FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

USDA Foreign Agricultural Service

Pakistan: Crop Progress Report

MY 2010/11

January Summary **January 29, 2009**

(1) The current outlook for national wheat production in the new MY 2010/11 growing season is below average at this early stage, given unfavorable early season rainfall and generally poorer than expected crop conditions in much of the nation's wheat growing region. In particular, Pakistan's major rainfed wheat growing areas (especially in northern Punjab) are showing very poor crop conditions and development as illustrated by satellite data (Figures 1, 18, 19). Current crop conditions in this region have the potential of causing wheat production to fall well-below normal this year. Non-irrigated wheat acreage in Punjab and North West Frontier Provinces (NWFP) combined totals approximately 1.0 million hectares (Table 1). Both these regions are currently experiencing drought-like conditions. The actual outcome of the main winter grain harvest will heavily rely on the quantity and timing of future rainfall events as well as adequate availability of irrigation supplies in both Punjab and Sindh provinces. Given rainfall in the winter months is usually quite low (Figure 6), it is possible there will not be additional relief for struggling crops in the non-irrigated portions of Pakistan's wheat growing region. And owing to the prevalence of less favorable crop conditions in the primarily irrigated growing areas this year, national wheat yield prospects are expected to be reduced from last years near-record levels.

(2) Season-to-date rainfall throughout Pakistan has been particularly low this year when compared to both the long-term average and last year (Figures 7, 8, 9). In particular, precipitation has been very low in the core rainfed growing areas of Punjab and the NWFP, where cumulative rainfall has totaled only 40 mm (Figure 7). In the past few growing seasons rainfall in these areas has averaged over 200 mm up to this point in the season, resulting in between 1.0 and 1.7 million tons of wheat production. Rainfed wheat acreage occupied over 1.2 million hectares last season, and is concentrated in the northern part of Punjab and in N.W.F.P (Figure 4 - 5). It is instructive to note that rainfall conditions in MY 2008/09 were similar to the low levels achieved this year. In that growing season, despite a strong resurgence of rainfall in January, rainfed wheat production declined 600,000 tons or 30 percent (Table 1, Figure 7). Given that extremely dry conditions prevailed throughout January 2010, MY 2010/11 rainfed wheat production in both Punjab and the NWFP is expected to be significantly lower than any season in recent history.

(3) A review of satellite-derived vegetative index data (NDVI) over Pakistan indicates that very dry conditions are hampering vegetative growth and development of the MY 2010/11 wheat crop (Figures 10 - 19). Peak vegetative development (peak NDVI) coincides with the reproductive growth phases of wheat in Pakistan (between wheat flowering stage and grain filling) and usually occurs from late February to early March. This period is also when the

crop's yield potential is set. This developmental calendar implies that there is still time for considerable improvement in overall national wheat conditions before the crop reaches the highly moisture sensitive reproductive growth stages, and before irreversible yield losses occur. However, time is running short. Weather conditions in February will be crucial to the overall outlook of national wheat yields and production. A national-scale NDVI analysis, comparing the current season against the previous 6-year average, indicates that overall wheat crop development is lagging behind normal in all major wheat growing regions (Figures 18, 25, 27). The previous five crop seasons in Pakistan coincidentally included the five largest wheat crops produced in the country since 1960. This year's crop, however, is currently in worse condition than any in the past six years. And of course, a similar vegetative index analysis comparing current crop conditions to MY 2009/10, a year when the country achieved its highest wheat production (Figures 2, 3), also indicates that the vast majority of wheat producing areas have much less favorable development (Figure 19, 26, 27). It appears that low rainfall early in the planting season (October and November), which delayed normal sowing operations and slowed early crop emergence was aggravated by the subsequent rainfall shortage in December and January (Figures 8 – 9). Lack of the late autumn – early winter rainfall negatively affected not only rainfed areas but many irrigated areas as well in both Punjab and Sindh.

(4) Considering the lower than normal rainfall this year, and crop stress observed over most of the country's wheat growing region, it is evident that irrigation water availability during the MY2010/11 season has been less than ideal. Pakistan has built one of the most extensive irrigation water distribution networks in the world, extending up to 56 thousand kilometers (Figures A3 – A4). Many canals work only on a rotational basis though, because there is not enough water to operate them simultaneously. It is also reported that up to two-thirds of the water in canals is lost through seepage. The upper reaches and tributaries of the Indus River have their headwaters in the Pakistani, Chinese, and Indian Himalayas. The river is fed by the snowmelt from six Himalayan glaciers that provide 90 percent of its flow. Several major dams and their accompanying reservoirs help to provide the majority of the nations irrigation supply, including Tarbela Dam on the Indus river, Mangla Dam on the Jhalum River, and Warsak Dam on the Kabul River (Figure A4). Reservoir recharge occurs between May and September coinciding with the peak snowmelt flow period of the Indus River and its tributaries (Figure A5). The winter grain irrigation season always corresponds to the lowest flow period in the Indus River basin, when the storage capacity of all reservoirs is very low; Pakistan can store only a 30-day supply. In November and December, 2009, the amount of precipitation over most of the upper Indus watershed was lower than normal (Figure A6) further reducing the meager inflow that otherwise would be available for winter reservoir recharge. Unfortunately, much of the water accumulated in the reservoirs during the 2009 summer high flow period has been already consumed by summer "kharif" crops (rice, cotton, sugarcane) and during the early months of the rabi wheat planting season. By January 2010 the abnormally low winter flow along the Indus River and its tributaries, combined with insufficient reservoir storage capacity and low water-use efficiency along the irrigation distribution networks has apparently created a general water supply problem for irrigated winter crops.

(5) Remote sensing change-detection analysis over Pakistan's major reservoirs indicated that the Mangla Reservoir capacity had declined by 77 percent between May 2009 and January 2010 (Figures 20 - 21). Lower than normal November to December rainfall over the watershed (Figure A6) and high irrigation consumption during the early phase of the winter crop season accelerated the reservoirs depletion. Smaller reservoirs in the Upper Indus basin experienced the same trend during this period. For example, the Khanpur Reservoir area in January 2010 is about 50 percent lower than at a similar point in time in 2008 (Figure 22). Tarbela Reservoir, which is located on the shared border of Punjab and NWFP, provides irrigation water for 50 percent of Pakistan's agricultural land. Its storage level, by comparison, has remained relatively stable during the recent calendar year (Figure 23). Overall, the evidence provided by this multi-reservoir monitoring analysis indicates that less stored water is available for irrigation at the onset of the peak vegetation growth this season. Lastly, the Indus Basin has almost 55 million acre-feet of fresh groundwater supplies. Groundwater now accounts for more than one third of all on-farm irrigation requirements (Table 2). Although groundwater quality is highly variable, tubewell numbers have doubled since the 1990 to more than 600,000 wells. Tubewell irrigation use increased in part because the government made electricity available at low or no cost.

(6) Up-to-date medium-resolution remote sensing data were very limited. The available images display examples of irrigation practices in Lower Indus valley on January 10, 2010, where both modern center-pivot sprinkler systems were operated on a limited scale and extensive waterlogging was observed along the irrigation canals (Figure 24). Monitoring of crop conditions using medium and high resolution remote sensing data will continue in February.

(7) NOAA's Climate Prediction Center is forecasting significant rains over the mountains in northern Pakistani provinces: up to 80 – 150 mm between January 27 and February 3, 2010. Light rains (less than 20 mm) could be expected in northern Punjab and portions of Baluchistan (Figure 28). The rain next week would help to replenish the exhausted reservoirs in the Upper Indus basin, but 20 mm of rain would generate only 2 mm of effective rainfall (P_e) over the rainfed cropping regions, given the prevailing evaporation rates at this time of year. Therefore it is not expected to significantly improve drought-affected crop conditions.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Table 1. Pakistan area and production of wheat crop, 2007 – 2009. *Data Source: Pakistan Ministry of food, Agriculture and Livestock.*

			2006-07			2007-08			2008-09
Production, 1,000 MT	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total
Pakistan, all	**21,390**	**1,905**	**23,295**	**19,634**	**1,325**	**20,959**	**22,411**	**1,622**	**24,033**
Punjab	16607.5	1245.5	17853.0	14812.4	794.6	15607.0	17406.06	1013.94	18420.00
Sindh	3331.6	77.6	3409.2	3382.5	28.9	3411.4	3508.08	32.10	3540.18
NWFP & FATA	633.8	526.6	1160.4	634.4	437.4	1071.8	689.80	514.69	1204.49
Baluchistan	816.7	55.4	872.1	804.9	63.7	868.6	806.63	61.58	868.21
Top10 Rainfed Districts	827	1,225	2,053	828	800	1,628	866	1,051	1,694
Top 10 Irrigated Districts	8,279	61	8,340	7,094	52	7,146	8,490	48	8,537
Area, 1,000 ha	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total
Pakistan, all	**7,335**	**1,244**	**8,578**	**7,370**	**1,180**	**8,550**	**7,821**	**1,225**	**9,046**
Punjab	5723.0	709.8	6432.8	5742.4	659.6	6402.0	6144.23	692.00	6836.23
Sindh	937.0	45.2	982.2	951.3	38.6	989.9	990.53	40.88	1031.41
NWFP & FATA	314.0	440.3	754.3	322.4	425.0	747.4	331.40	438.11	769.51
Baluchistan	360.6	48.3	408.9	354.1	56.4	410.5	355.00	54.05	408.93
Top10 Rainfed Districts	340	701	1,041	372	650	1,022	383	688	1,071
Top 10 Irrigated Districts	2,718	32	2,750	2,667	34	2,701	2,885	48	2,933

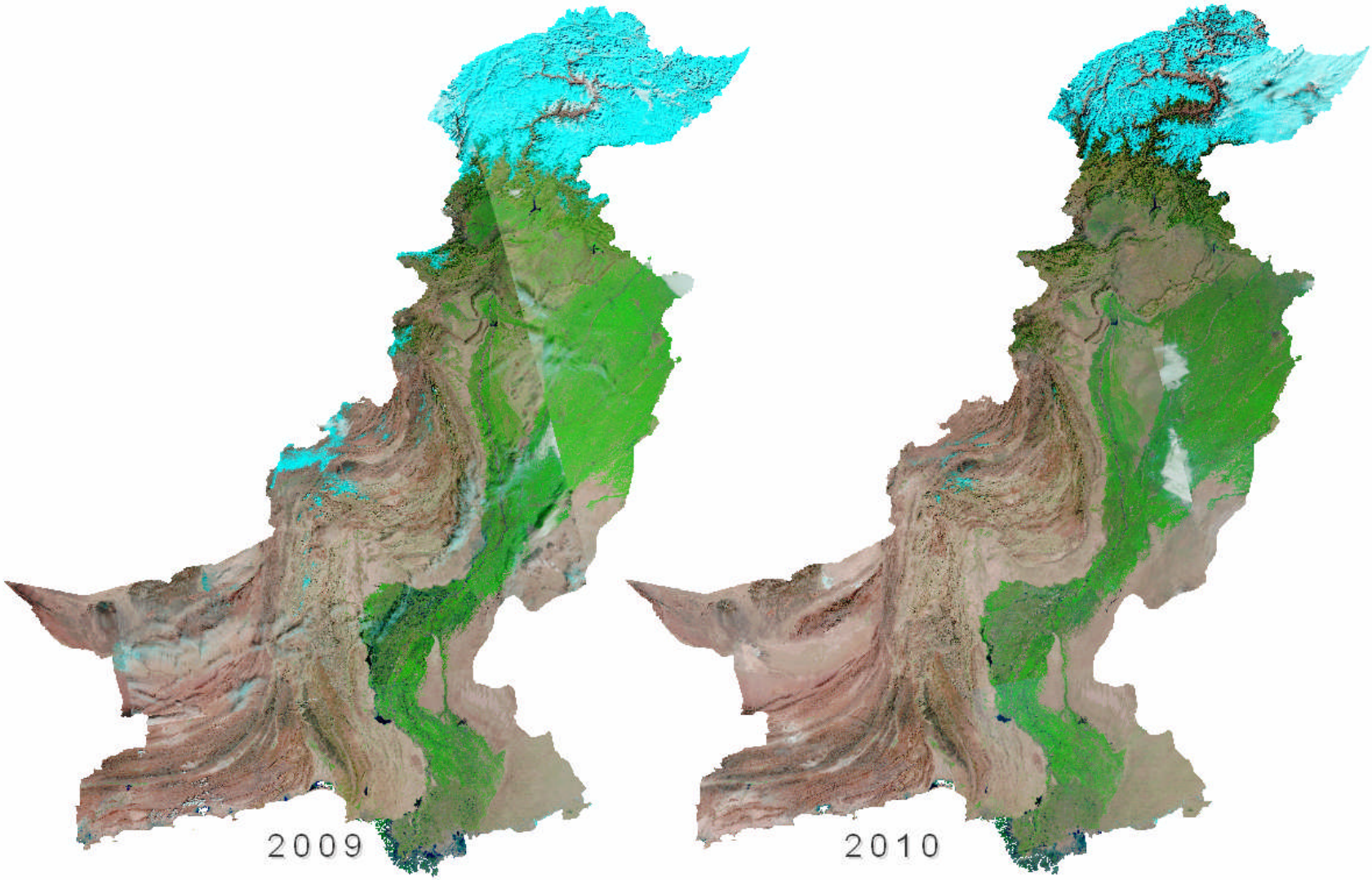
Table 2. Cropped area, water availability and agriculture growth rate in Pakistan.

Year	Total Cropped Area (Mha)	Surface Water, km^3	Ground Water, km^3	Total Water, km^3	Agriculture Growth (%)
2001-02	22.12	103.73	61.55	165.28	-0.1
2002-03	21.84	107.38	62.00	169.38	4.1
2003-04	23.04	119.80	62.00	181.80	2.4
2004-05	22.90	101.11	62.00	163.11	6.5
2005-06	23.12	124.11	61.88	185.99	6.3
2006-07	23.50	115.99	62.37	178.36	3.7
2007-08	23.51	118.94	62.00	180.95	1.5
Average	22.86	113.01	61.98	174.98	3.49

Data Source: World Bank; Pakistan Economic Survey 2007-08, Finance Division, Economic Advisor's Wing, Ministry of Finance, Government of Pakistan (GoP); Pakistan Statistical Year Book-2008, Federal Bureau of Statistics, Government of Pakistan (GoP).

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Cloudless MODIS Imagery Mosaic, Mid-January 2009 and 2010



Data Source: MODIS Terra 7-2-1
Crop Explorer
Supporting: USDA/FAS/OGA/IPAD

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 1. Pakistan Mid-January green-up conditions in 2010 compared to 2009. *Data Source: MODIS 7-2-1 mosaic; tiles dated between 01/12 and 01/20, 2009 and 2010.*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

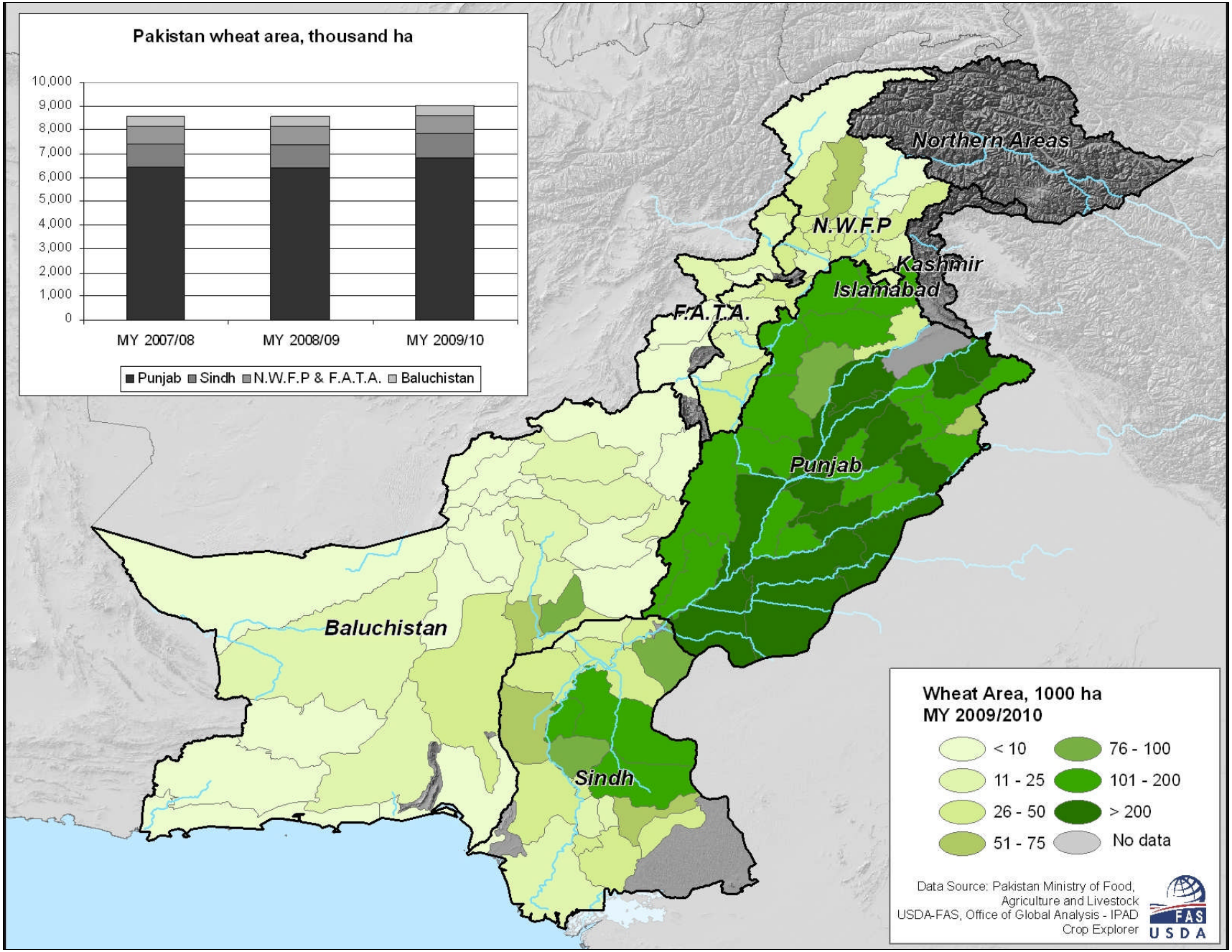


Figure 2. Provincial and district-wise distribution of wheat cropland areas in Pakistan in MY 2007 – 2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

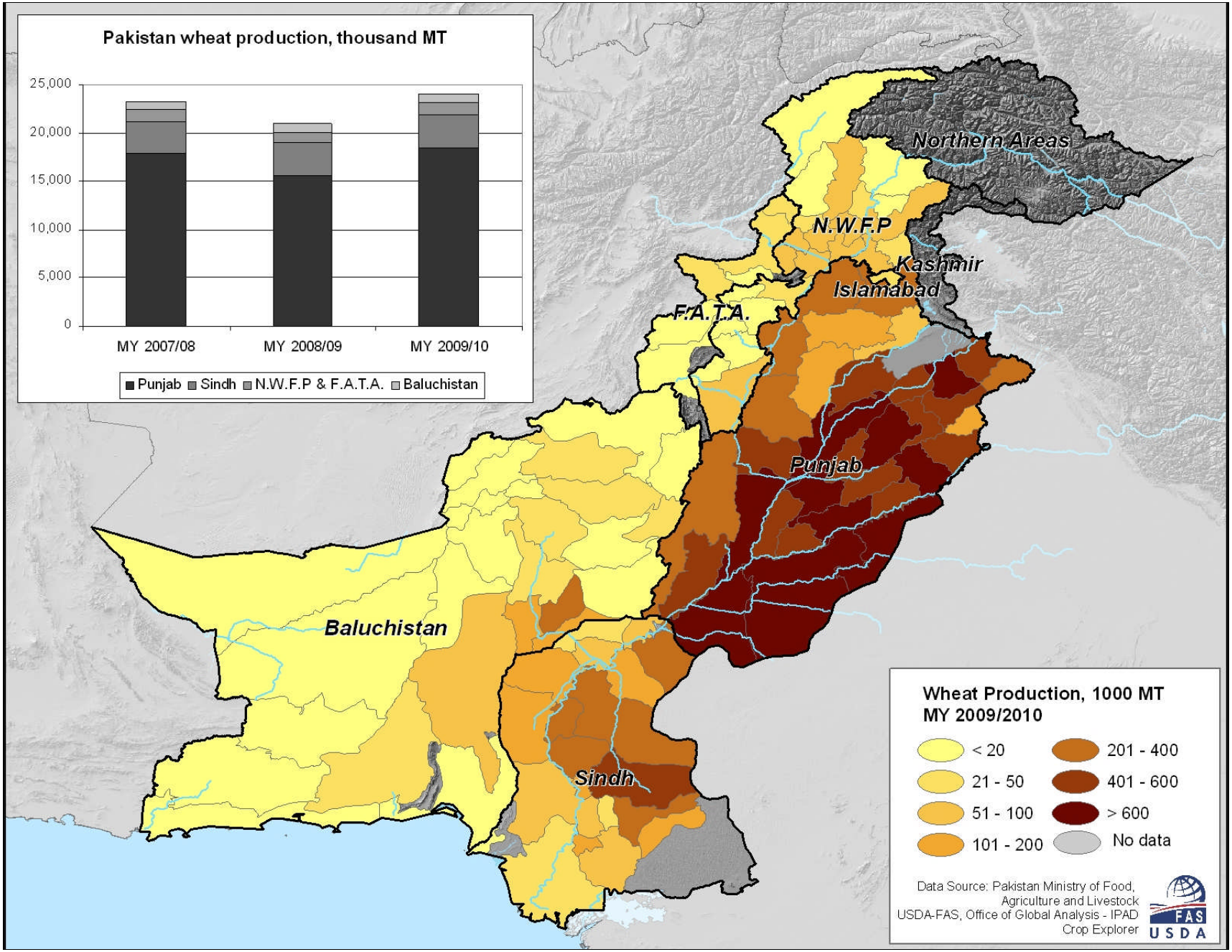


Figure 3. Provincial and district-wise distribution of wheat production in Pakistan in MY 2007 – 2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

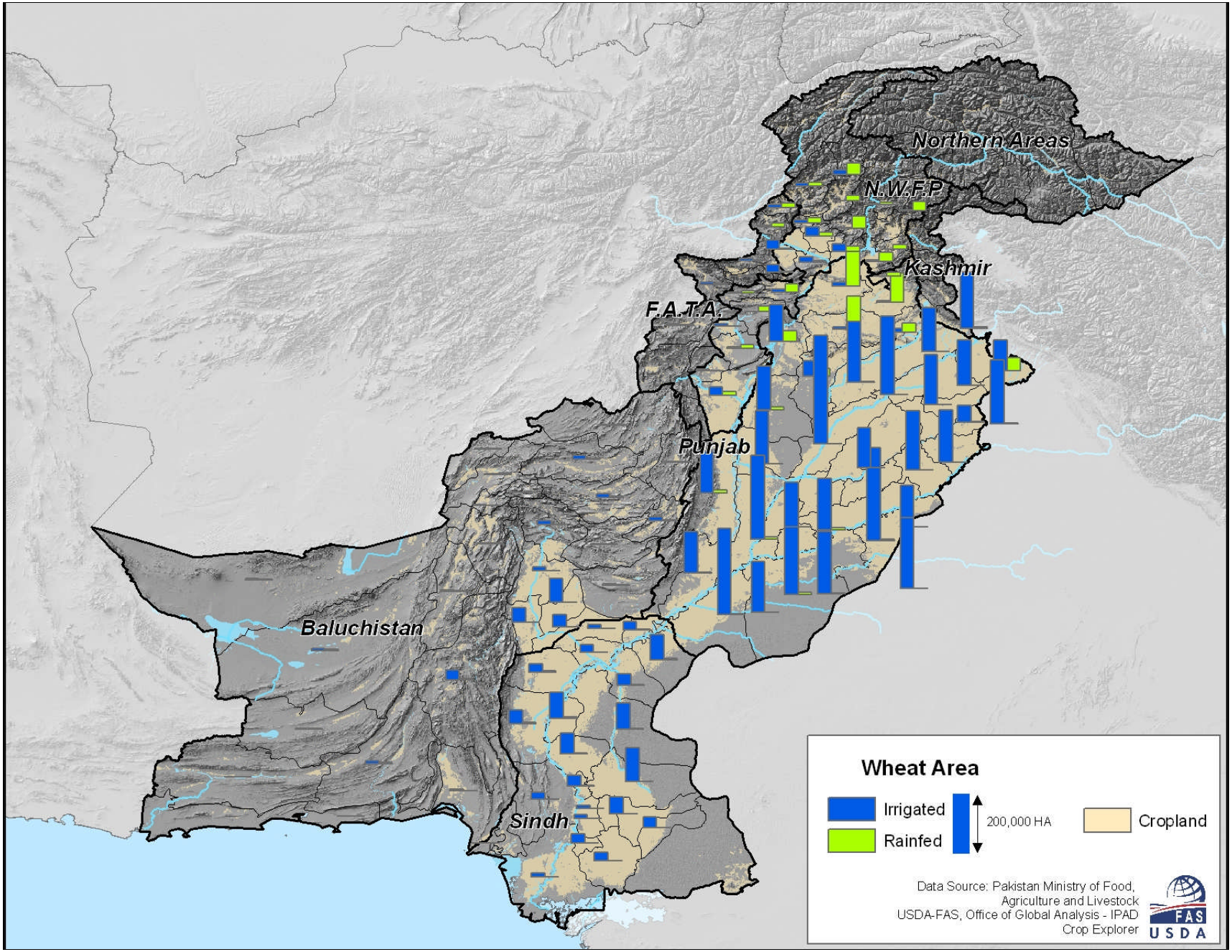
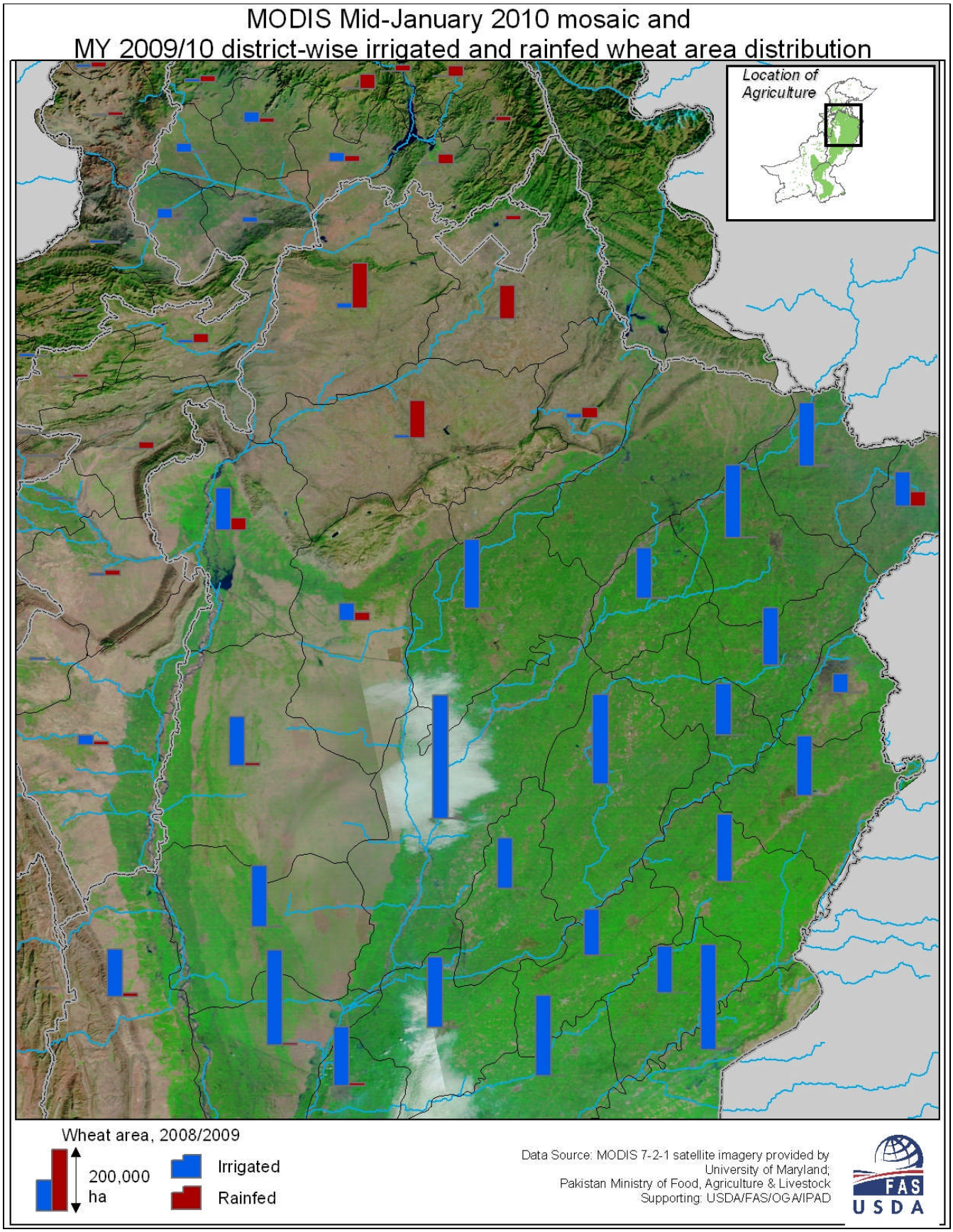


Figure 4. Distribution of irrigated and rainfed wheat crop in Pakistan administrative districts in MY 2009/2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

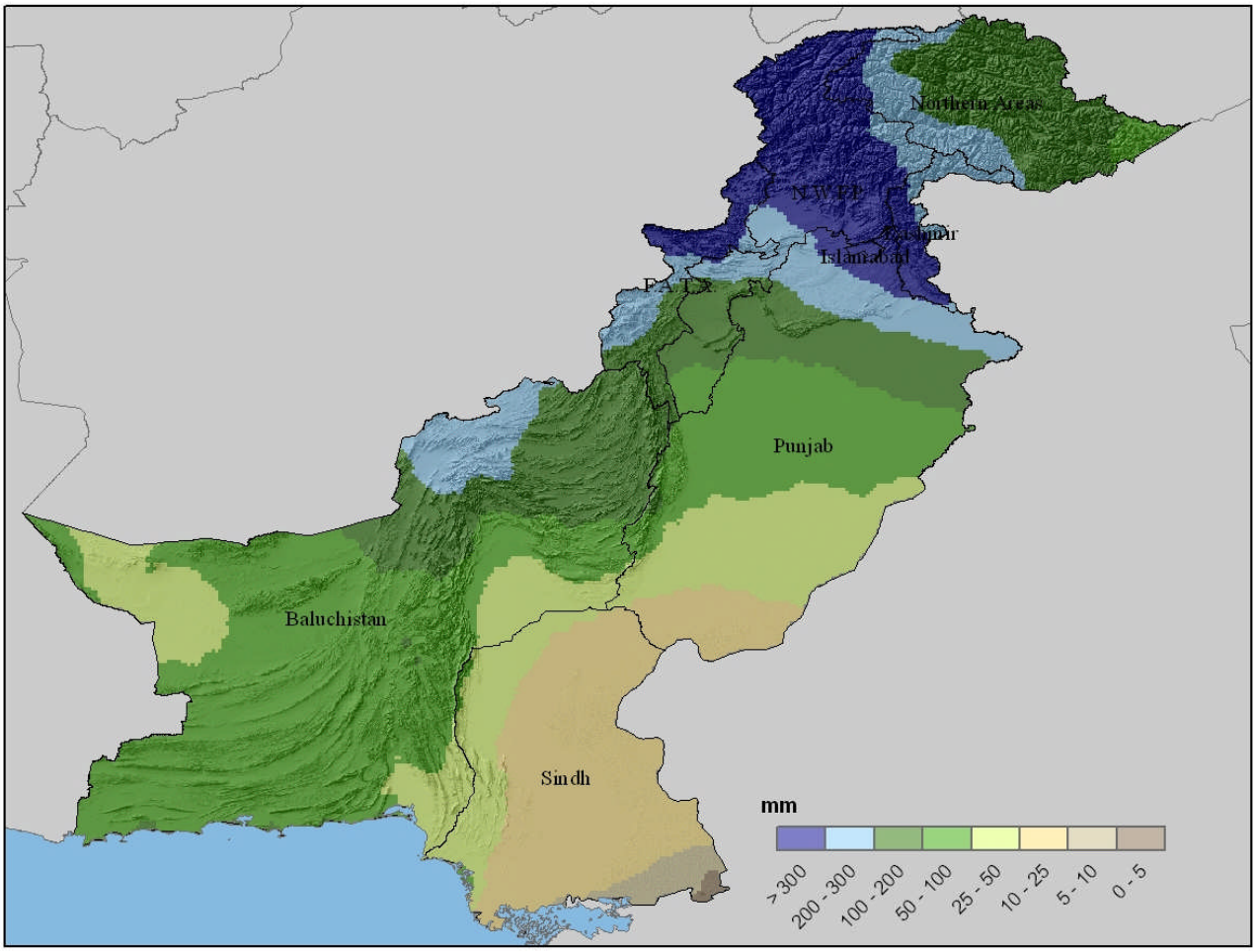


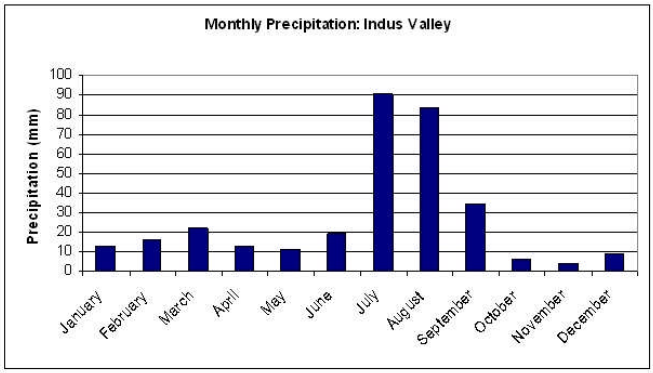
FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

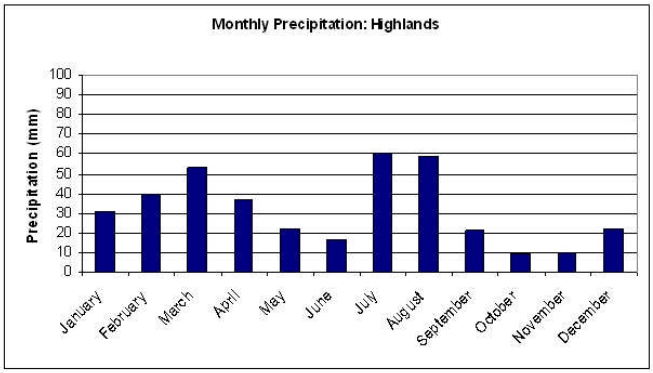
Figure 5. Mid-January green-up conditions in major irrigated and rainfed wheat areas of Pakistan.
Data Source: MODIS 7-2-1 mosaic; tiles dated between 01/13 and 01/15, 2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Pakistan Average Rabi Season (November-April) Precipitation (mm)







Data Source: AFWA Precipitation
USDA-FAS,
Office of Global Analysis- IPAD
Crop Explorer

Arable lands

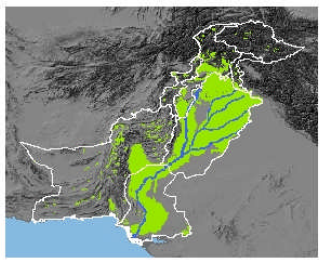
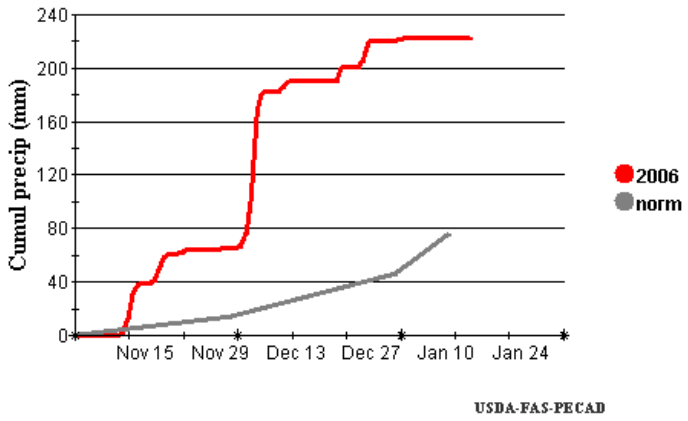
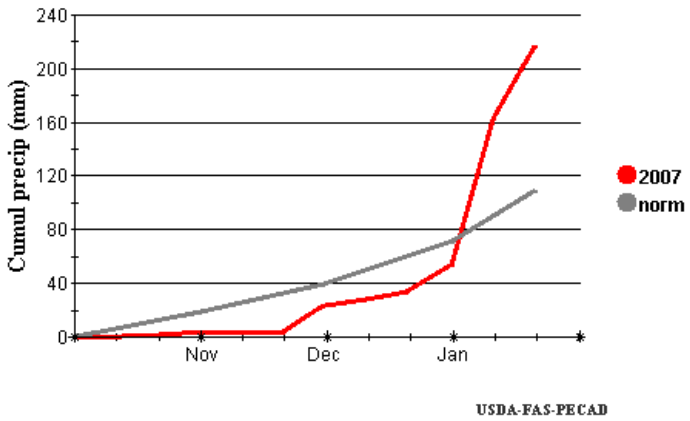


Figure 6. Normal cumulative precipitation during Rabi season (November – April). *Data source: AWFA*

Precipitation during start of the winter crop season over the major rainfed wheat producing districts of Punjab and N.W.F.P.

MY 2007/08	MY 2008/09
	
MY 2009/10	MY 2010/11

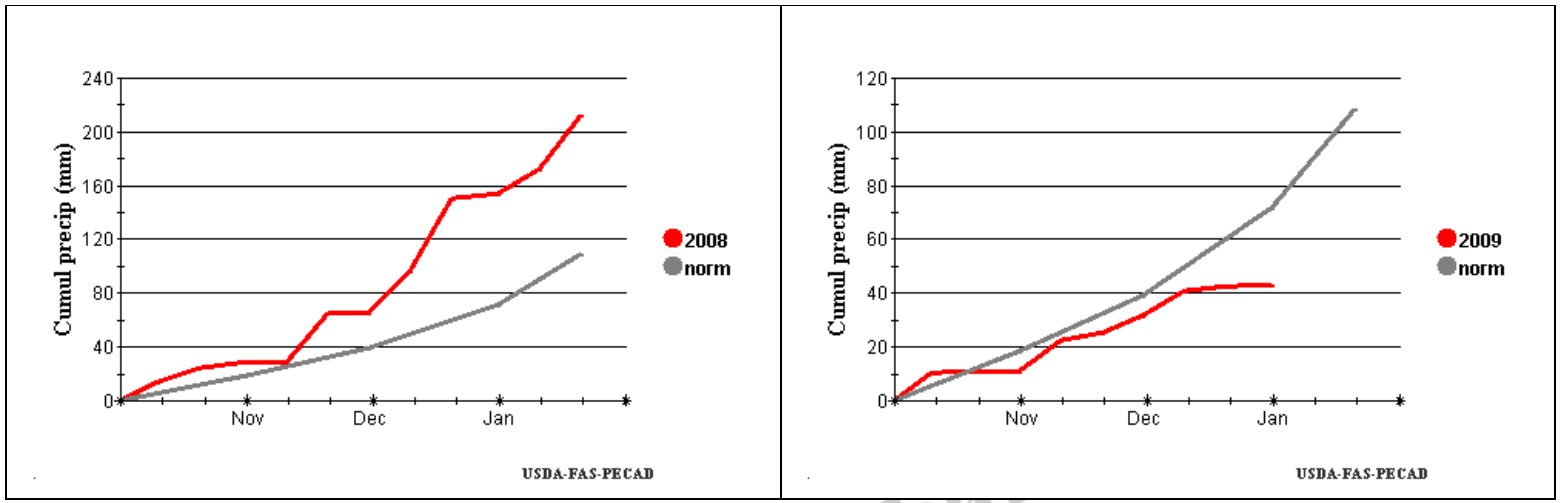


Figure 7. Precipitation during start of the winter crop season over the major rainfed wheat producing districts of Punjab and N.W.F.P. in 2006 – 2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

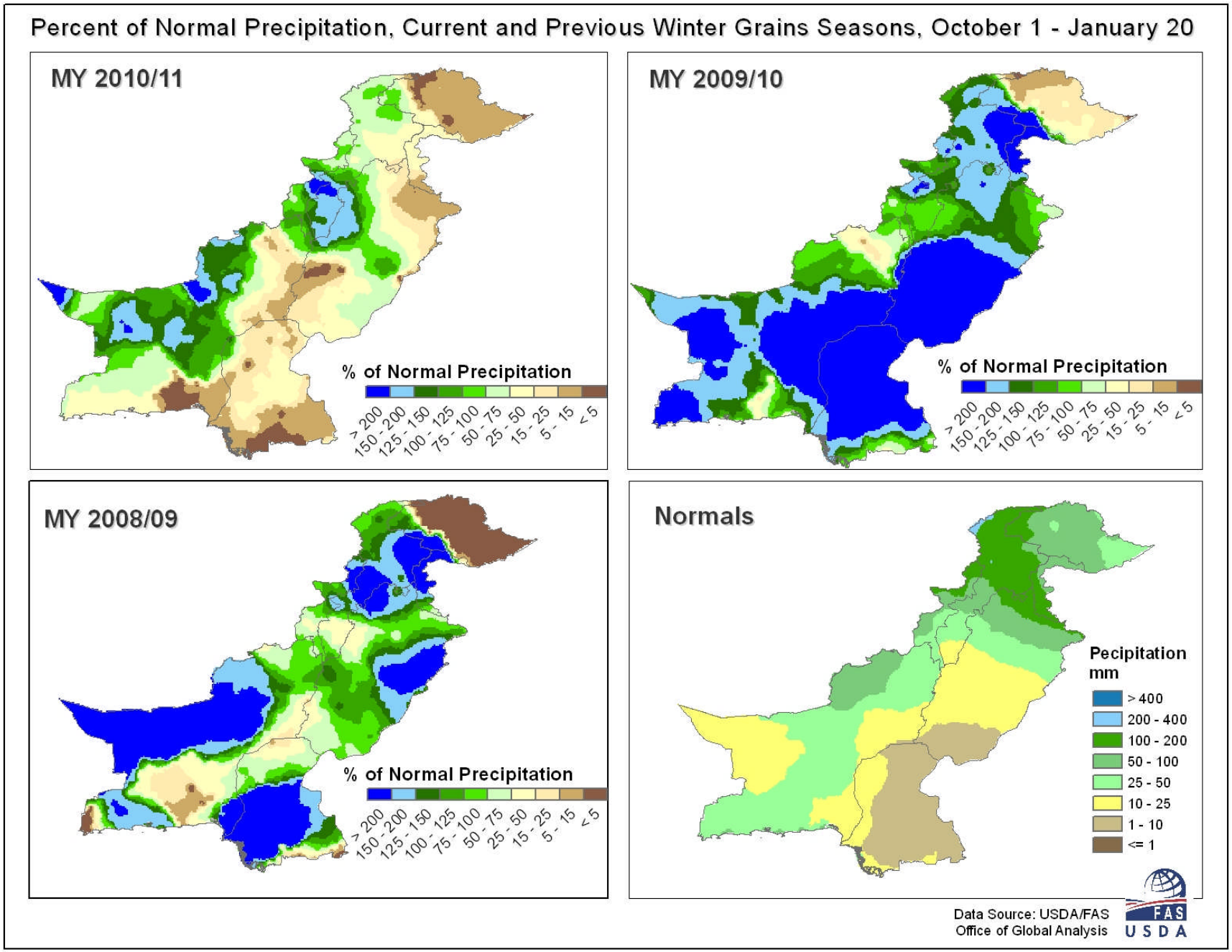


Figure 8. Cumulative precipitation norm and percent of normal rainfall during current and prior two wheat seasons, October 1 – January 20, 2007 -2010.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

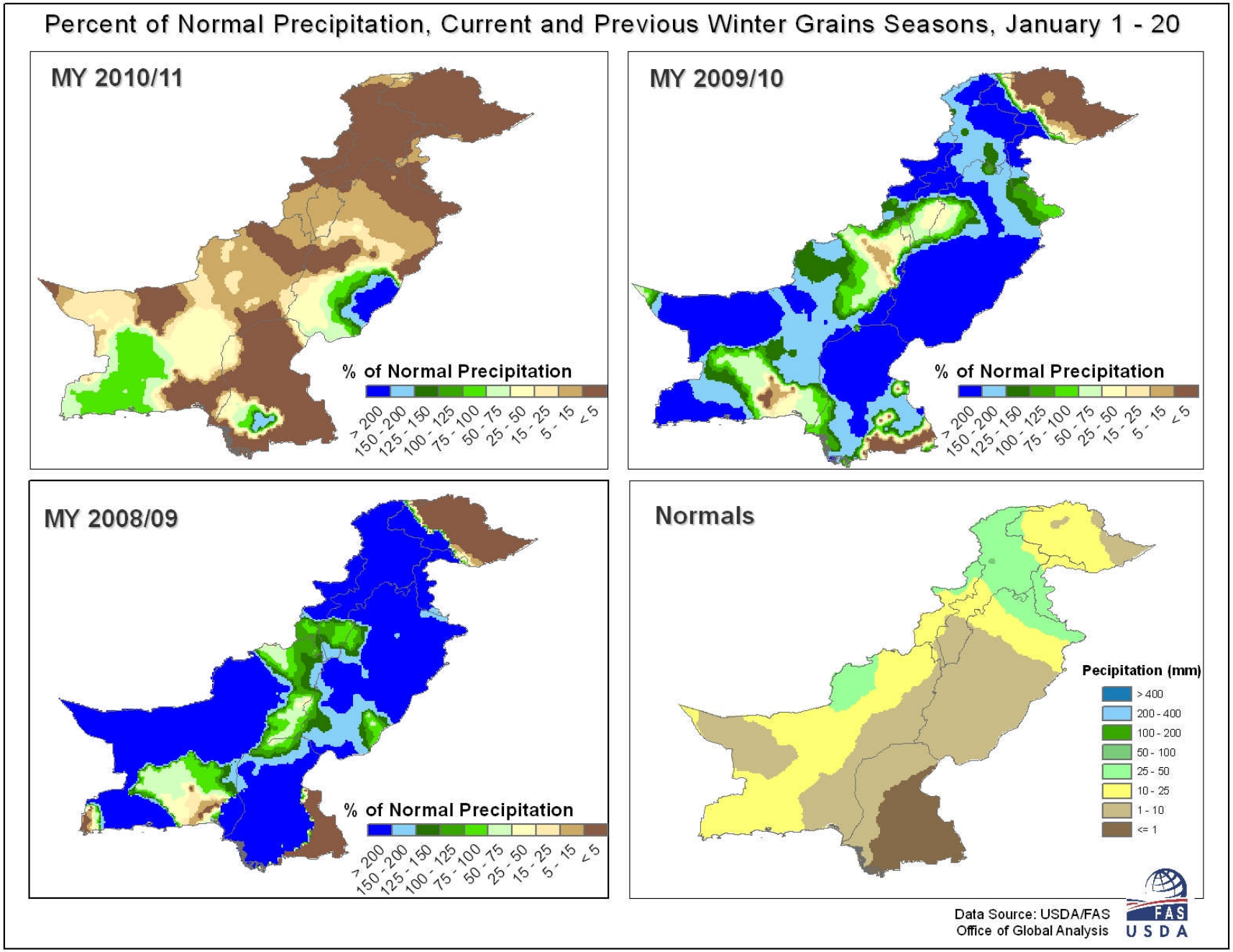


Figure 9. Cumulative precipitation norm and percent of normal rainfall during current and prior two wheat seasons, January 1-20, 2008-2010.

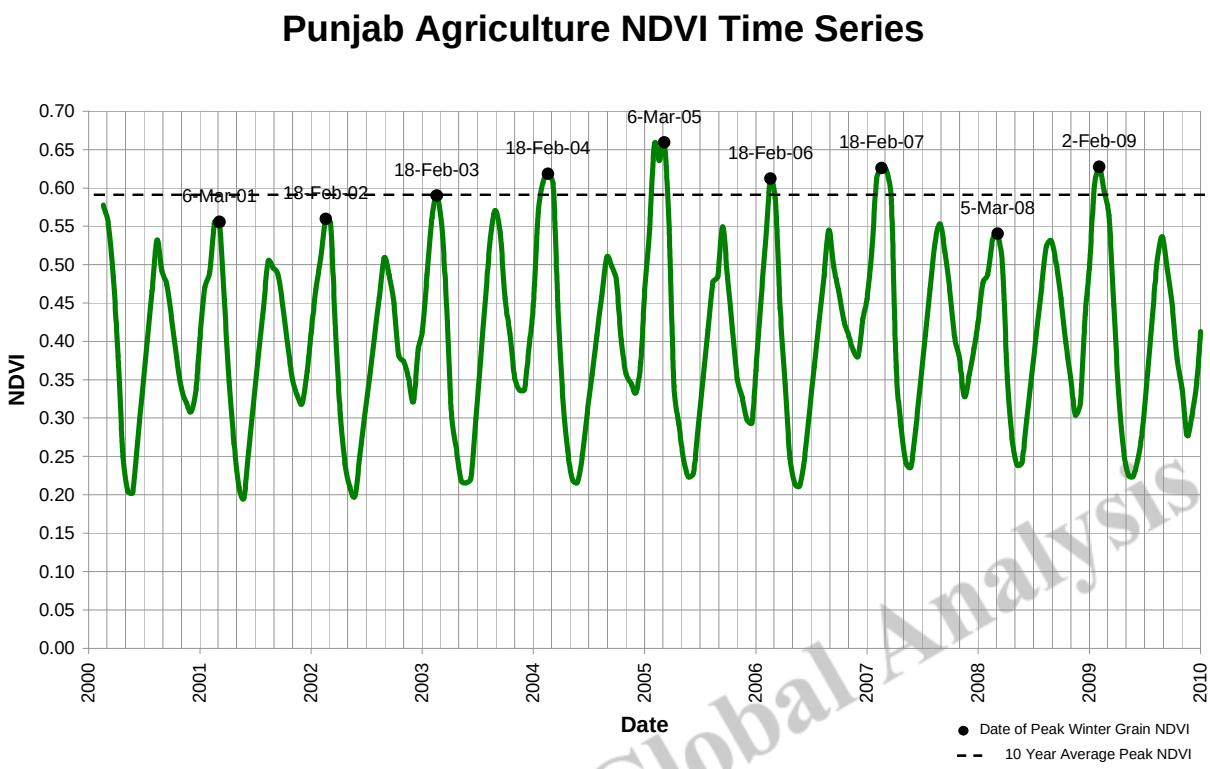


Figure 10. NDVI time series over Punjab Province, Pakistan. Punjab produces almost 77% of all wheat.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

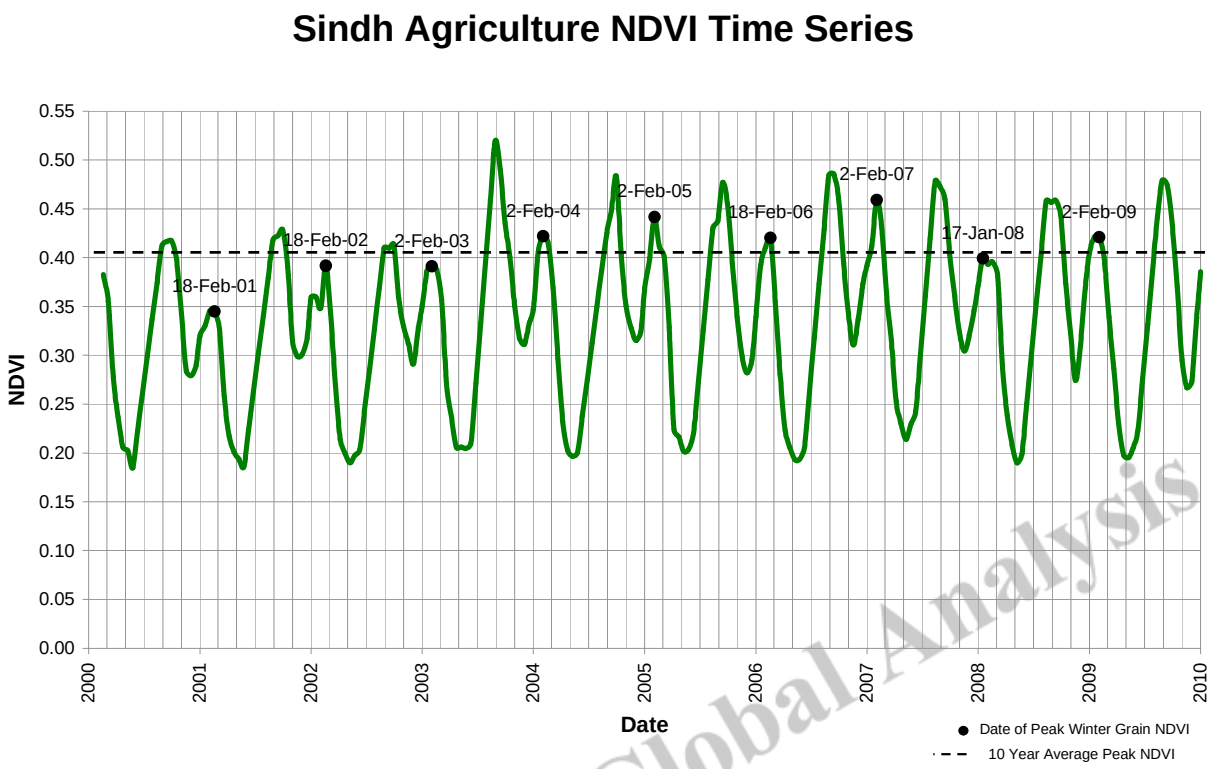


Figure 11. NDVI time series over agricultural areas of Sindh Province, Pakistan. Sindh produces almost 15% of all wheat.

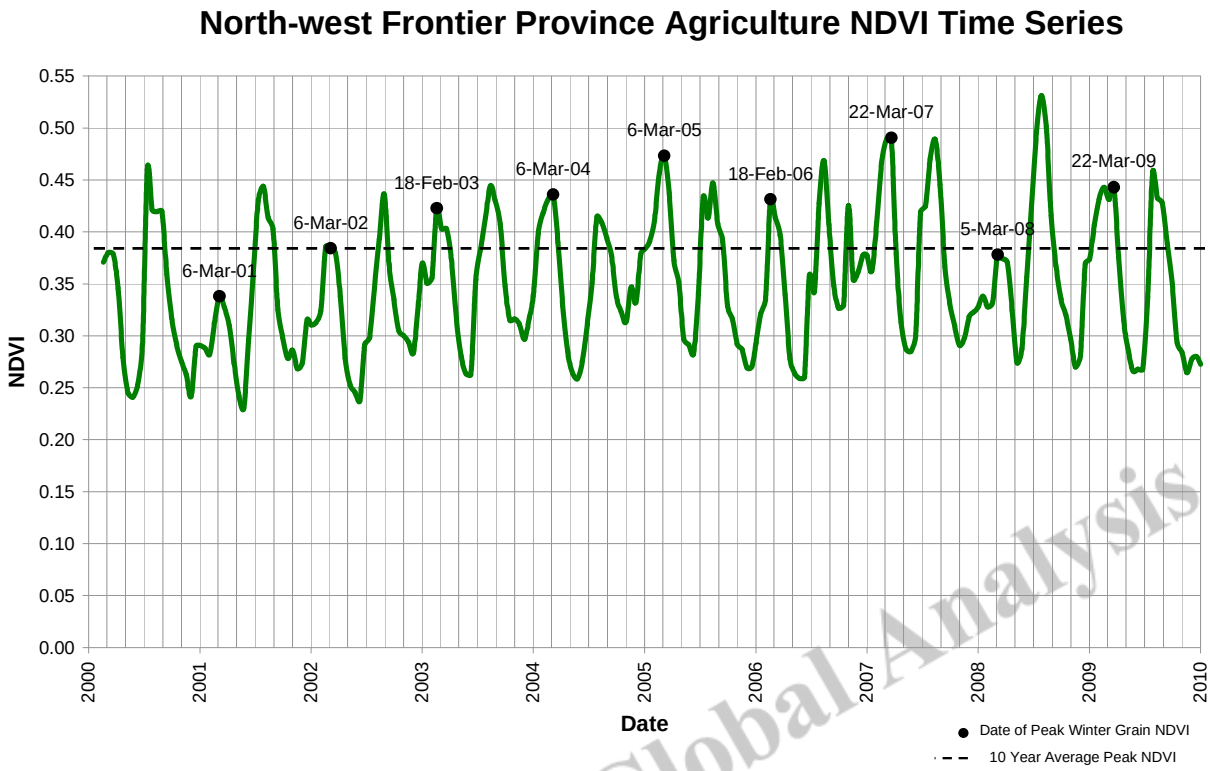


Figure 12. NDVI time series over agricultural areas of Northwest Frontier Province, Pakistan.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

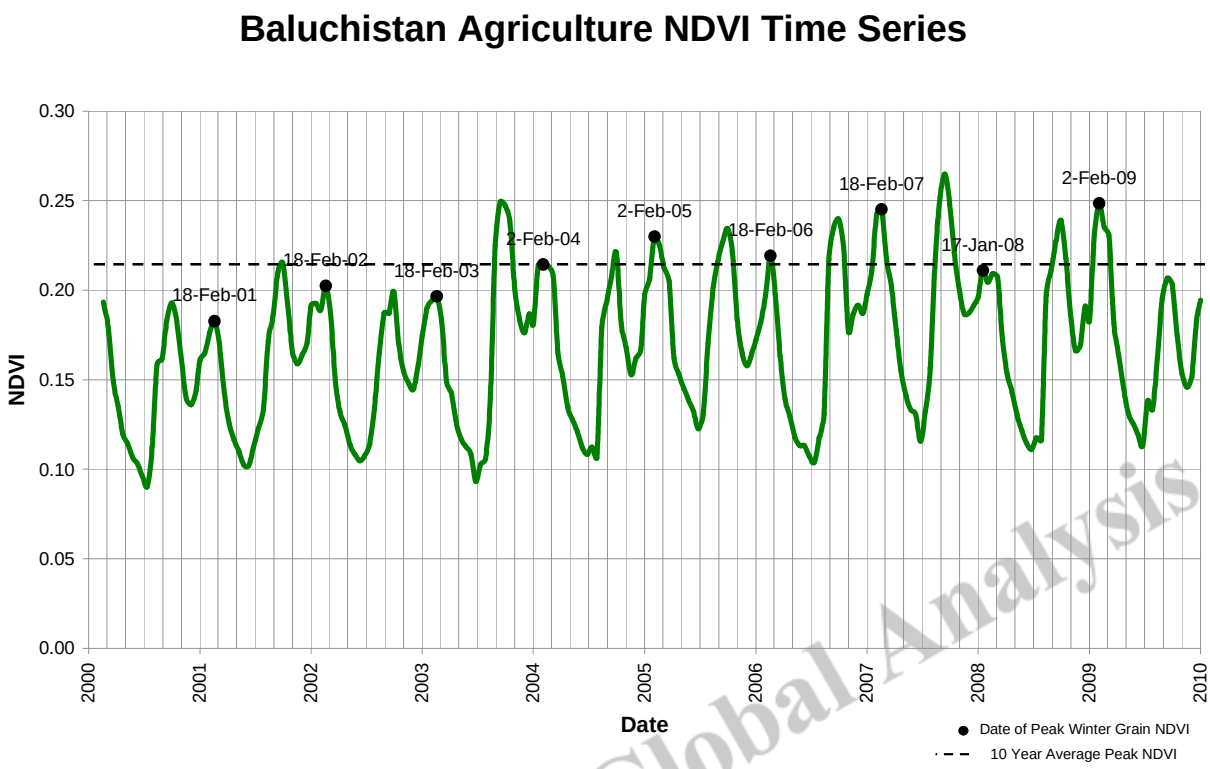


Figure 13. NDVI time series over agricultural areas of Baluchistan Province, Pakistan.

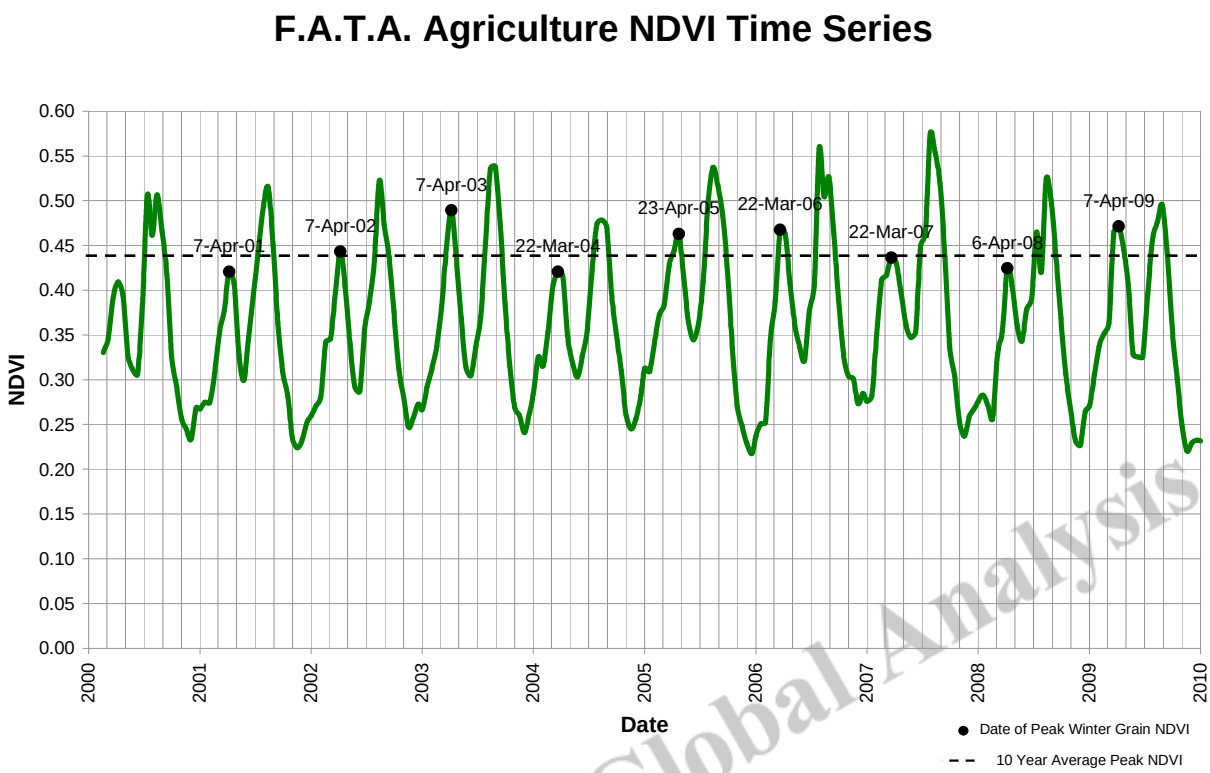


Figure 14. NDVI time series over agricultural areas of F.A.T.A. Province, Pakistan.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

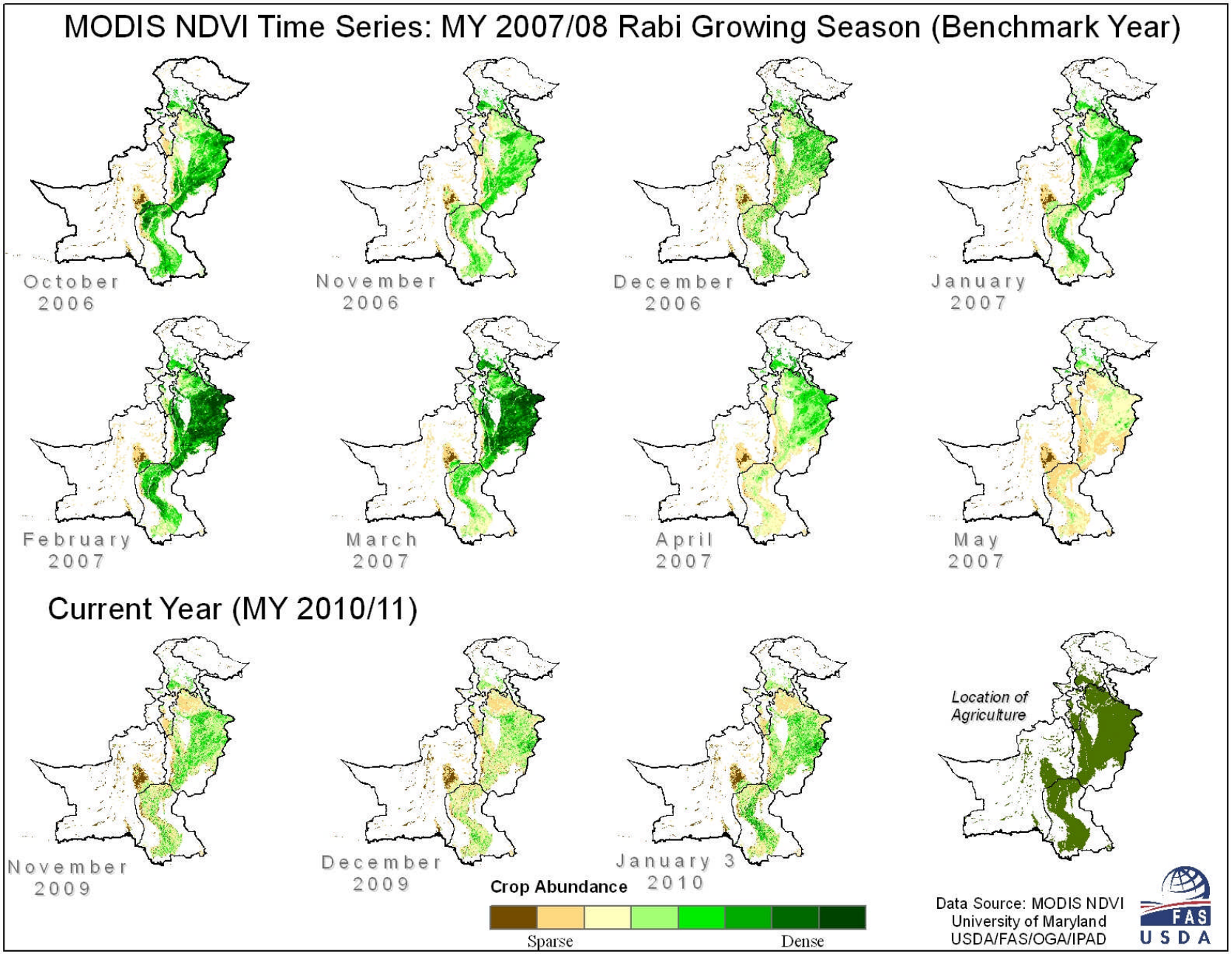
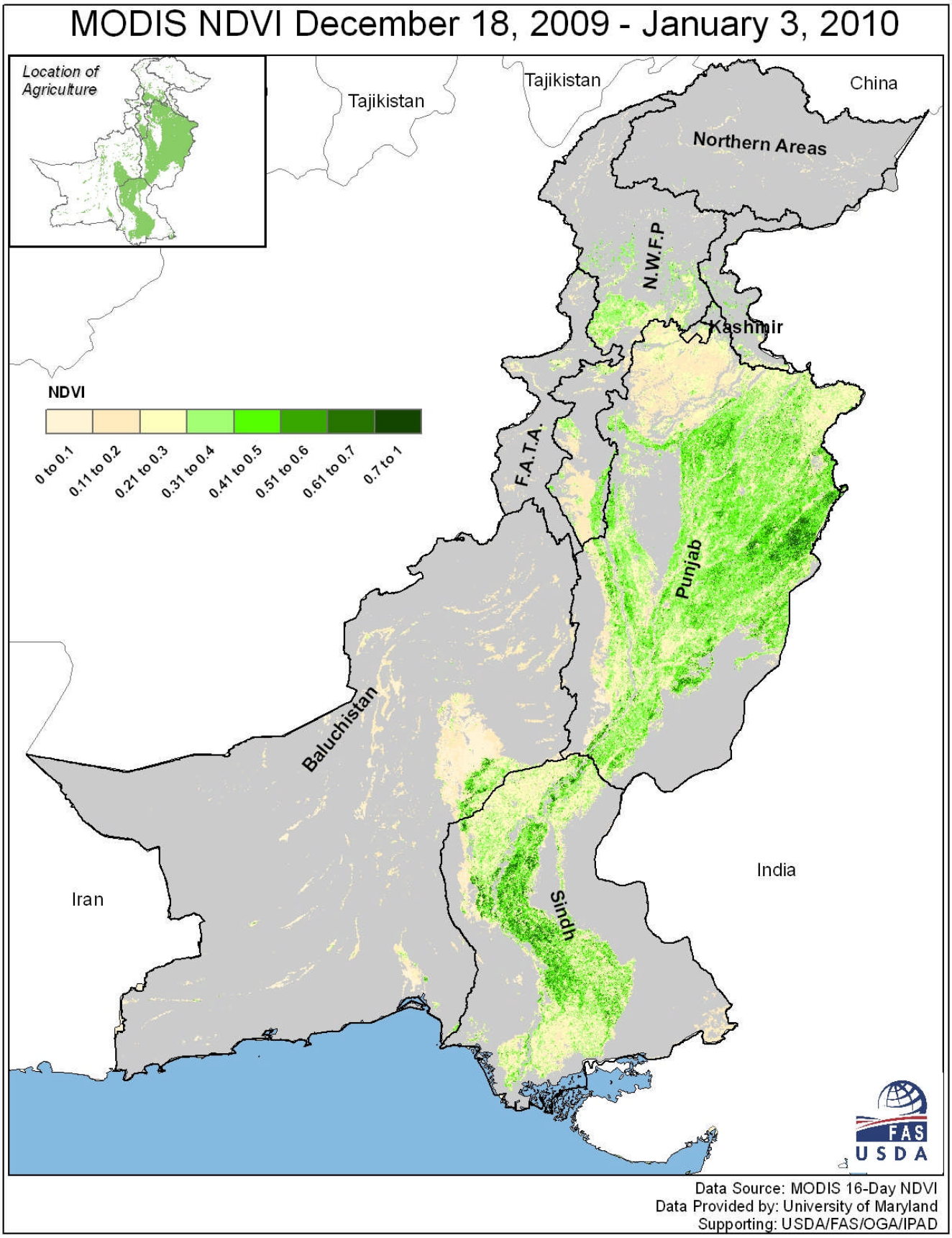


Figure 15. Vegetation growth through the winter grains growing season. Peak occurs from late February to early March. *Data Source: MODIS NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

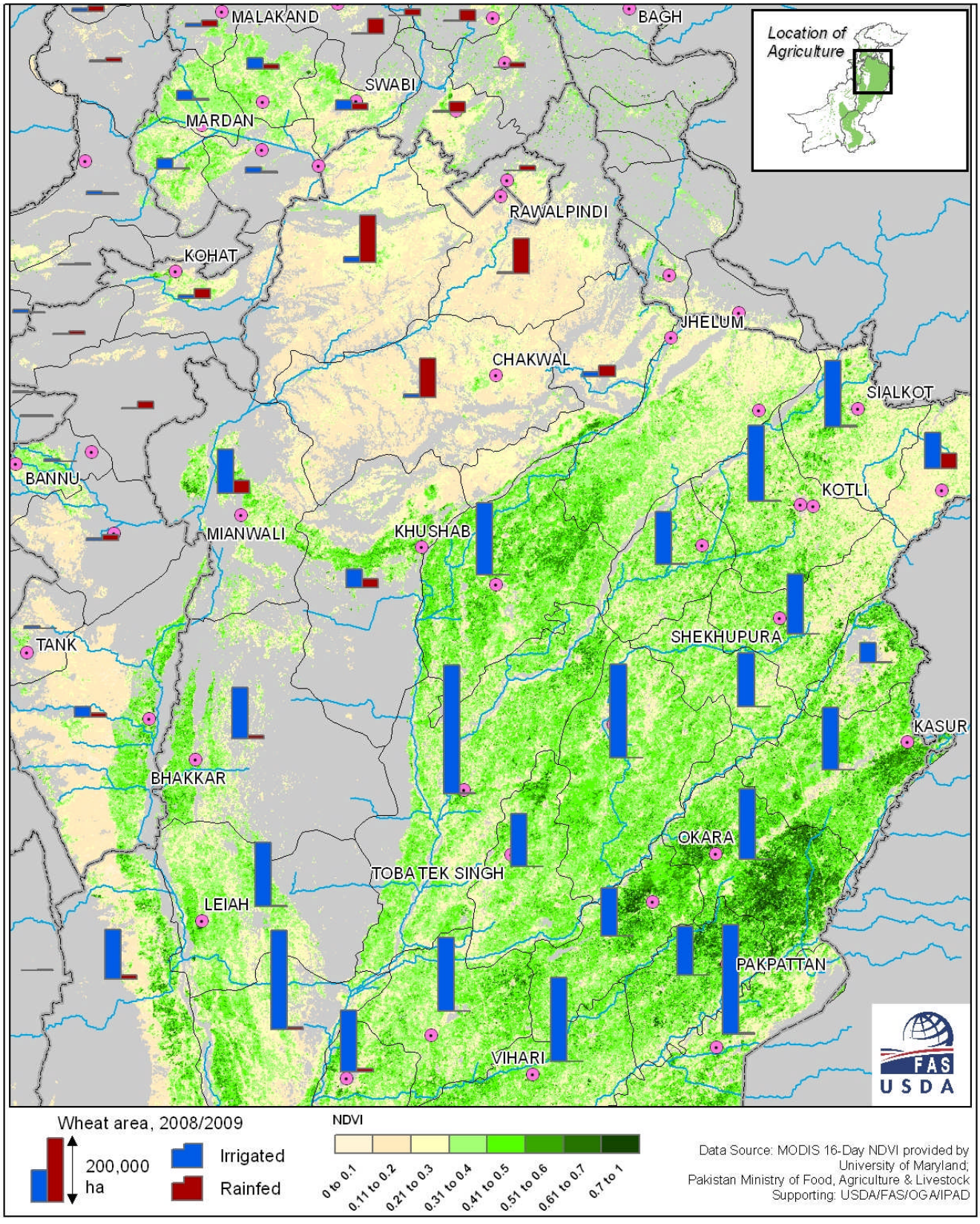


FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 16. MODIS NDVI, December 18, 2009 – January 3, 2010. *Data Source: MODIS 16-Day Composite*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

MODIS NDVI,12/18/2009 - 3/1/2010, and Wheat Cropland, MY 2009/10

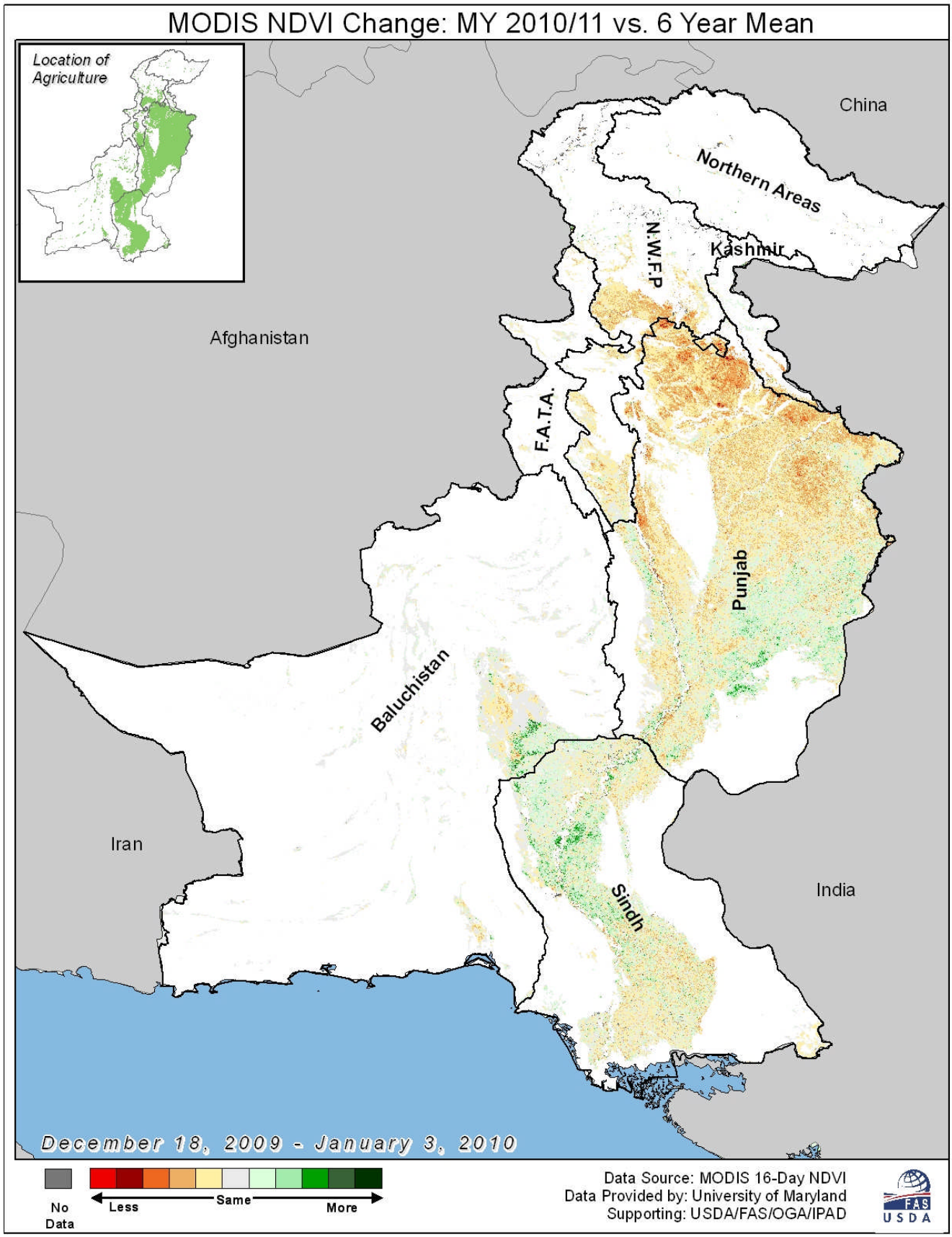


FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 17. Crop status in major wheat producing areas, December 18, 2009 – January 3, 2010. *Data Source: MODIS 16-Day*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

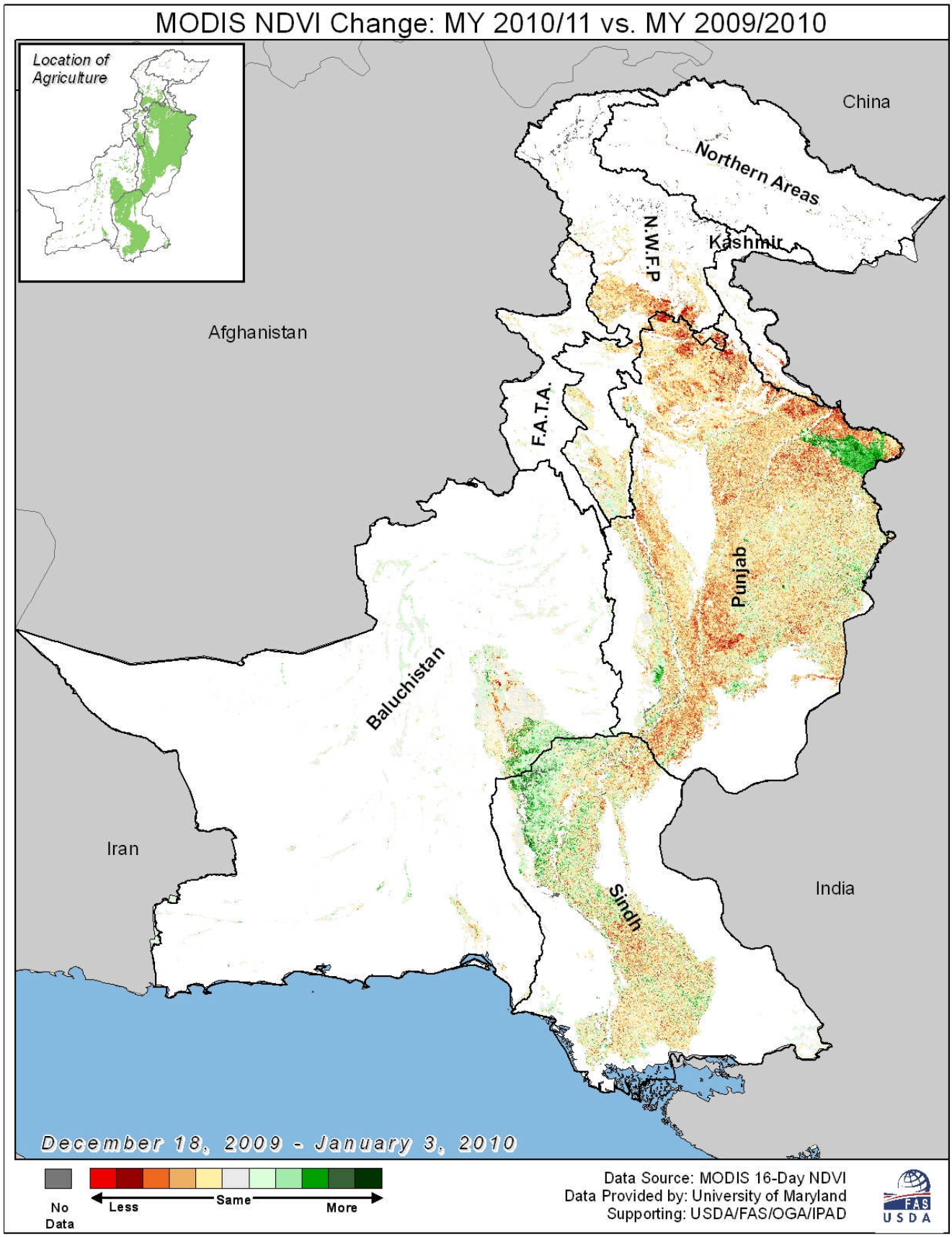
FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program



FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 18. MODIS NDVI 6-yr anomaly, December 18, 2009 – January 3, 2010. *Data Source: MODIS 16-Day NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

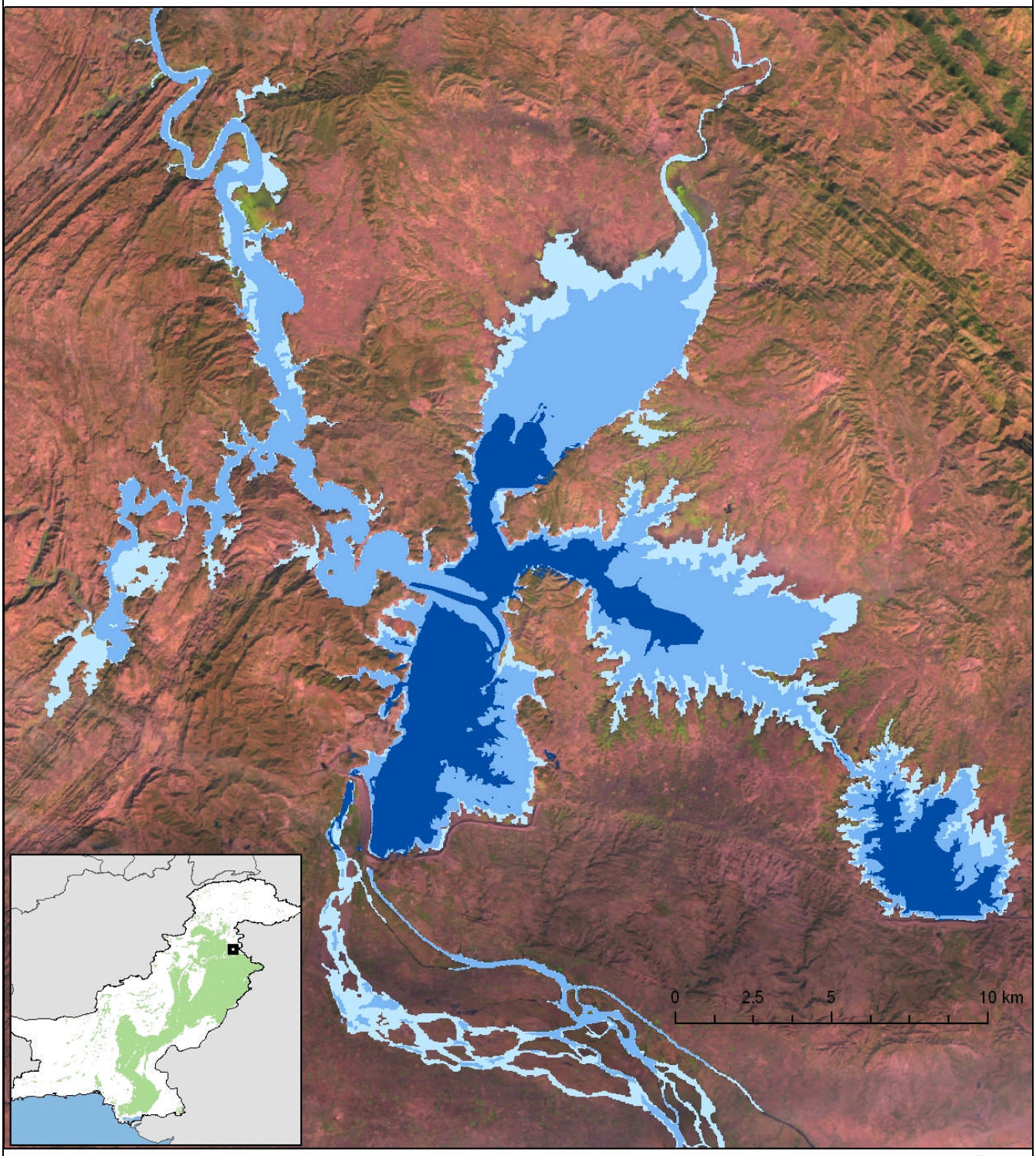


FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 19. MODIS NDVI 1-yr anomaly, December 18, 2009 – January 3, 2010. *Data Source: MODIS 16-Day NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Mangla Reservoir Dynamics, 2009 - 2010



Reservoir Area

01/01/2010	11/22/2009	05/30/2009
Area = 45.8 sq.km	Area = 144.8 sq.km	Area = 196.2 sq.km

Data Source: USDA-FAS
Office of Global Analysis
International Production
Assessment Division
Landsat

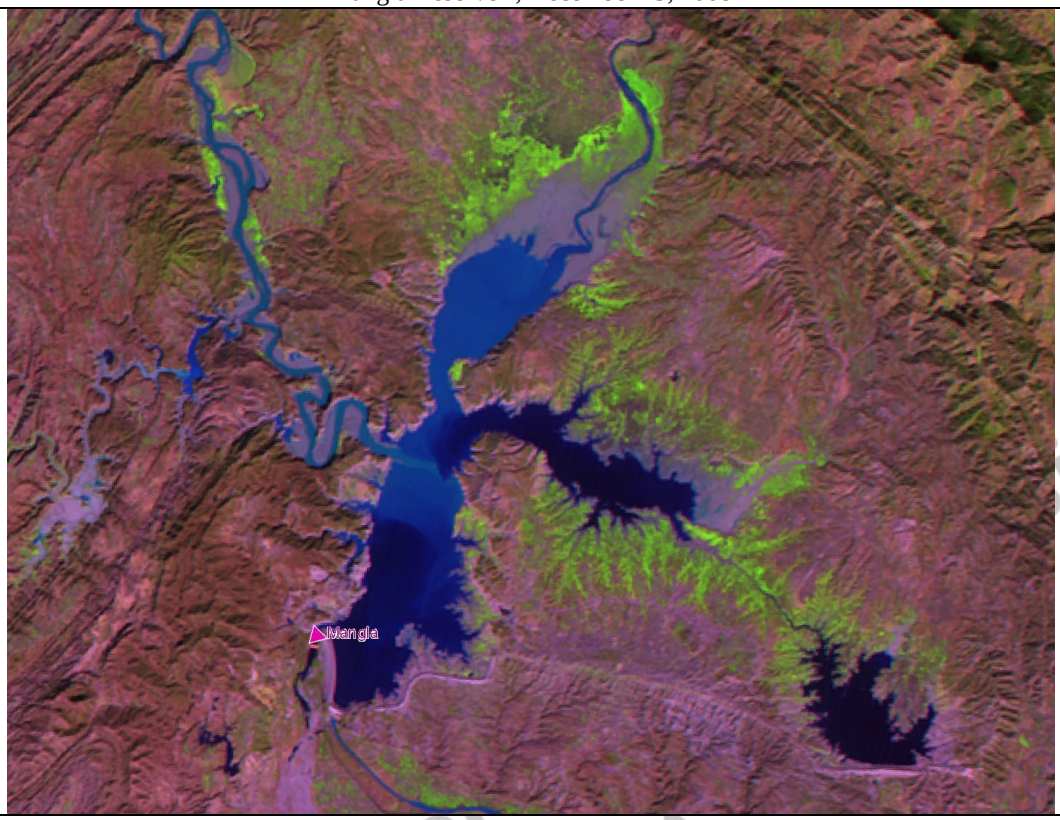
FAS USDA

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Figure 20. Mangla Reservoir Dynamics, 2009 – January, 2010. *Data Source: Landsat, AWiFS*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Mangla Reservoir, December 23, 2008



Mangla Reservoir, January 1, 2010

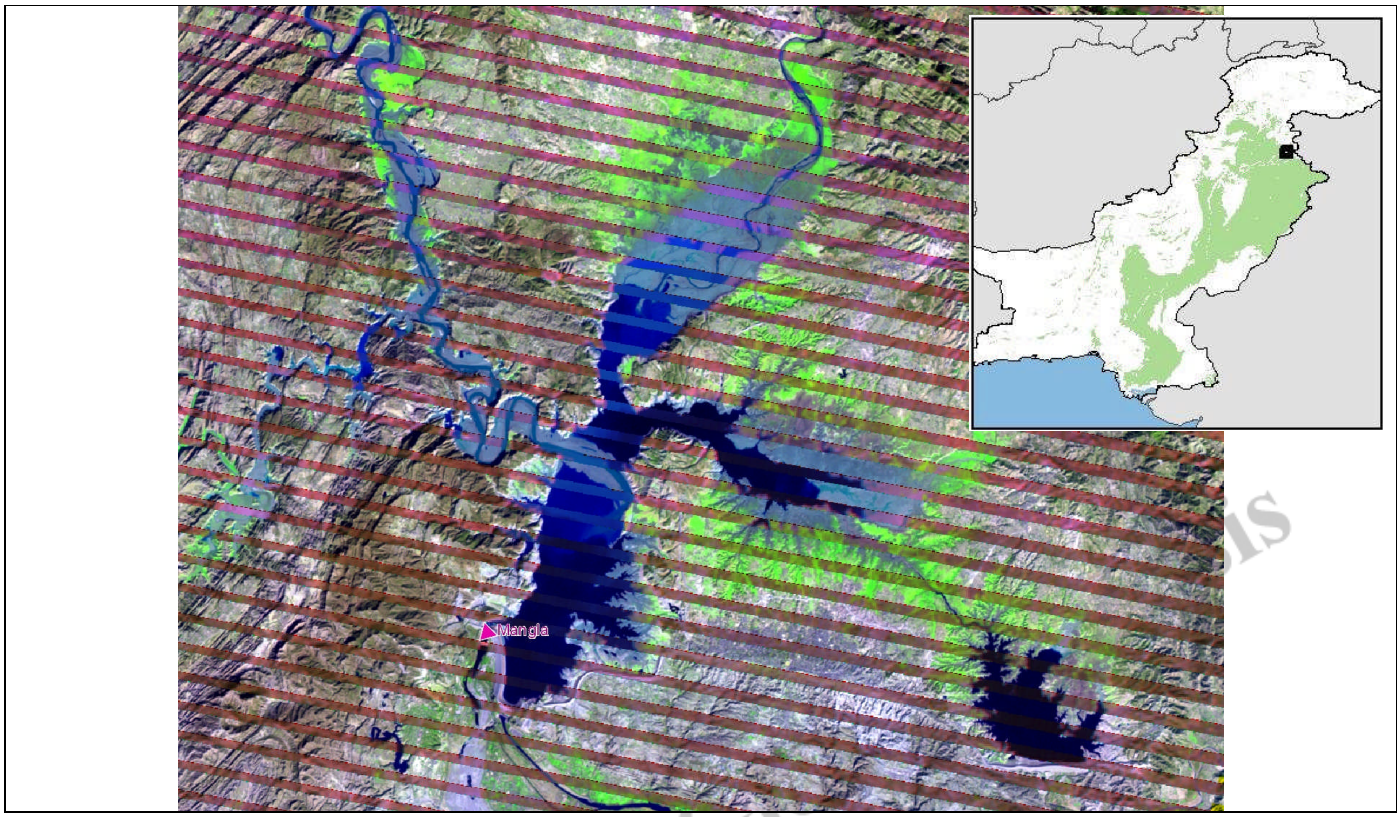
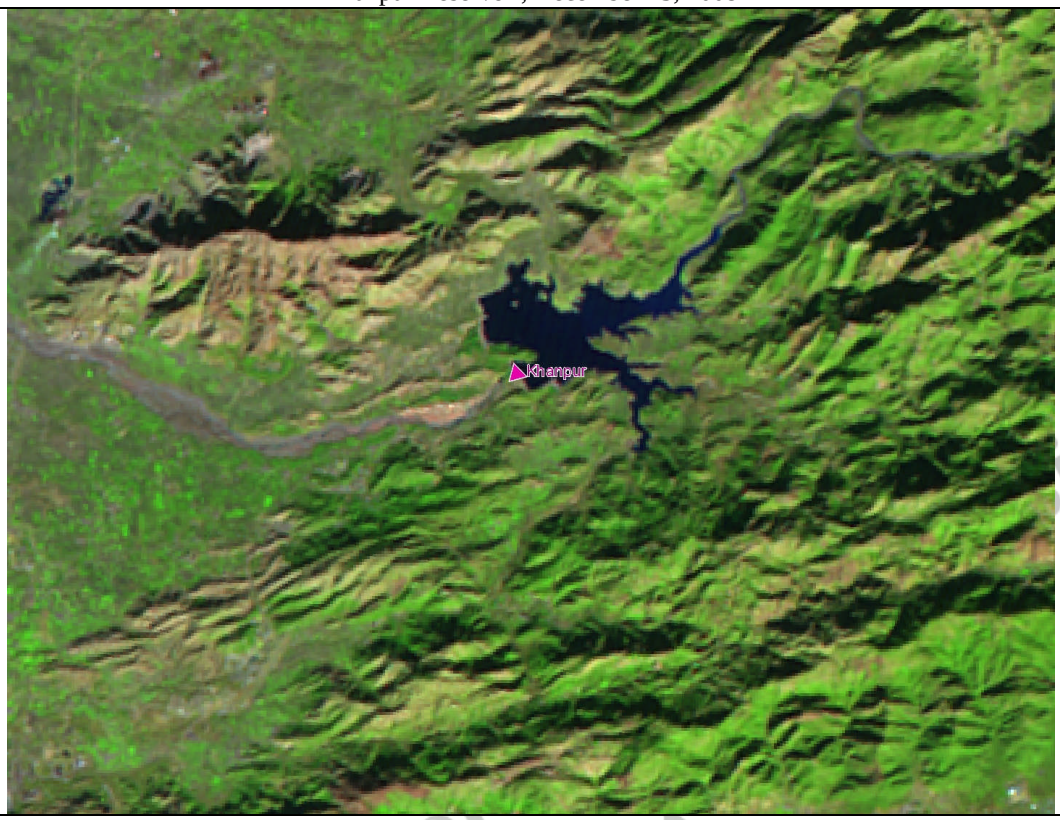


Figure 21. Upper Indus Reservoirs: Mangla, December 23, 2008 compared to January 1, 2010. *Data Source: Landsat, AWiFS*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Khanpur Reservoir, December 23, 2008



Khanpur Reservoir, January 1, 2010

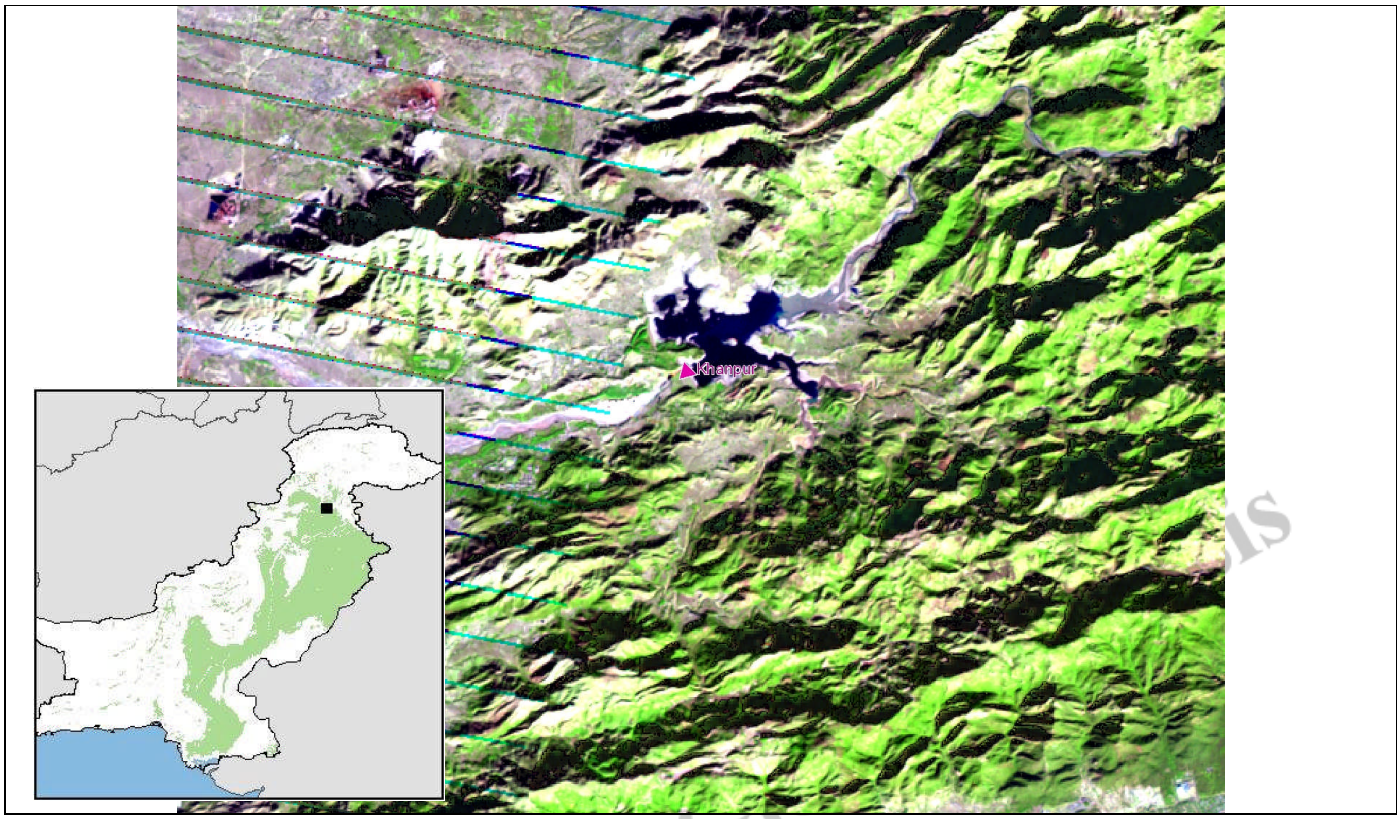
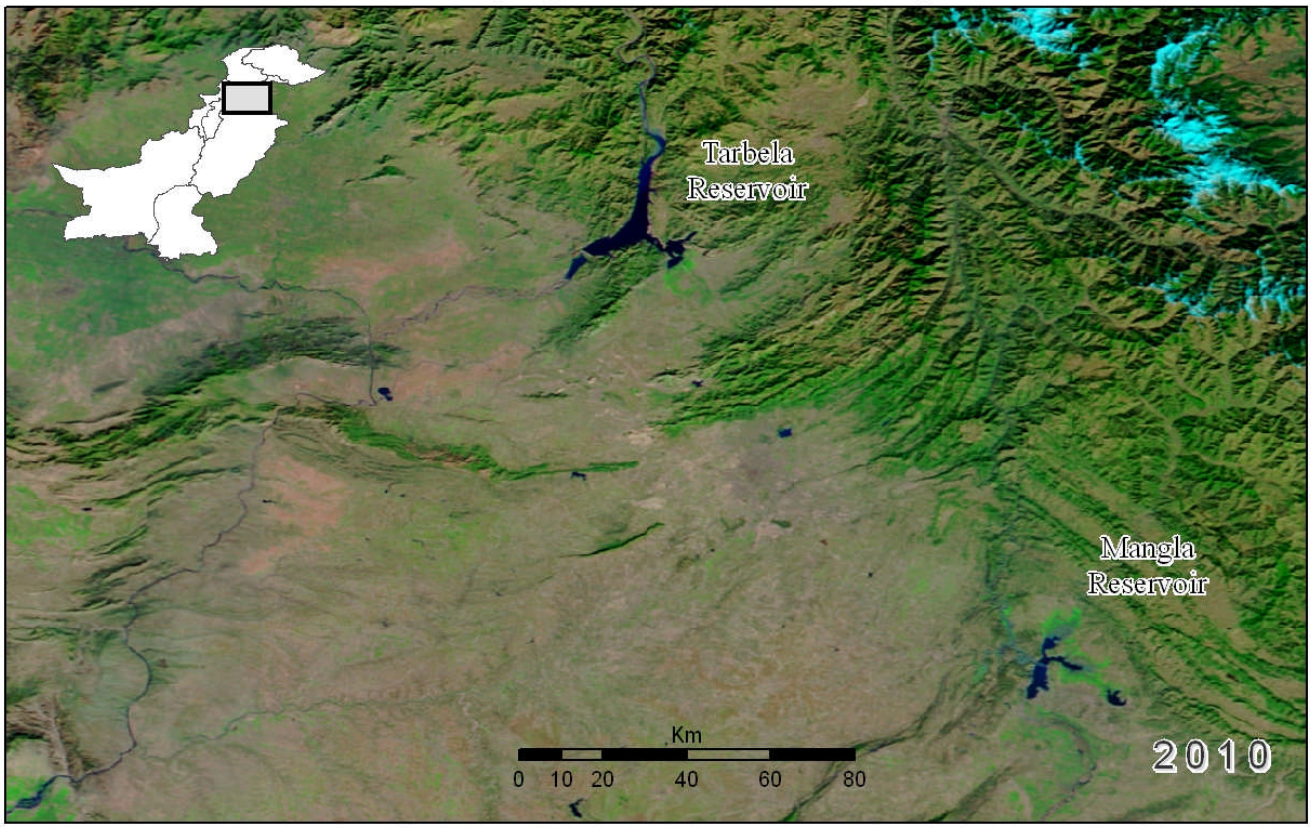


Figure 22. Upper Indus Reservoirs: Khampur, December 23, 2008 compared to January 1, 2010. *Data Source: Landsat, AWiFS*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Cloudless MODIS Imagery Mosaic, Mid-January 2009 vs. 2010



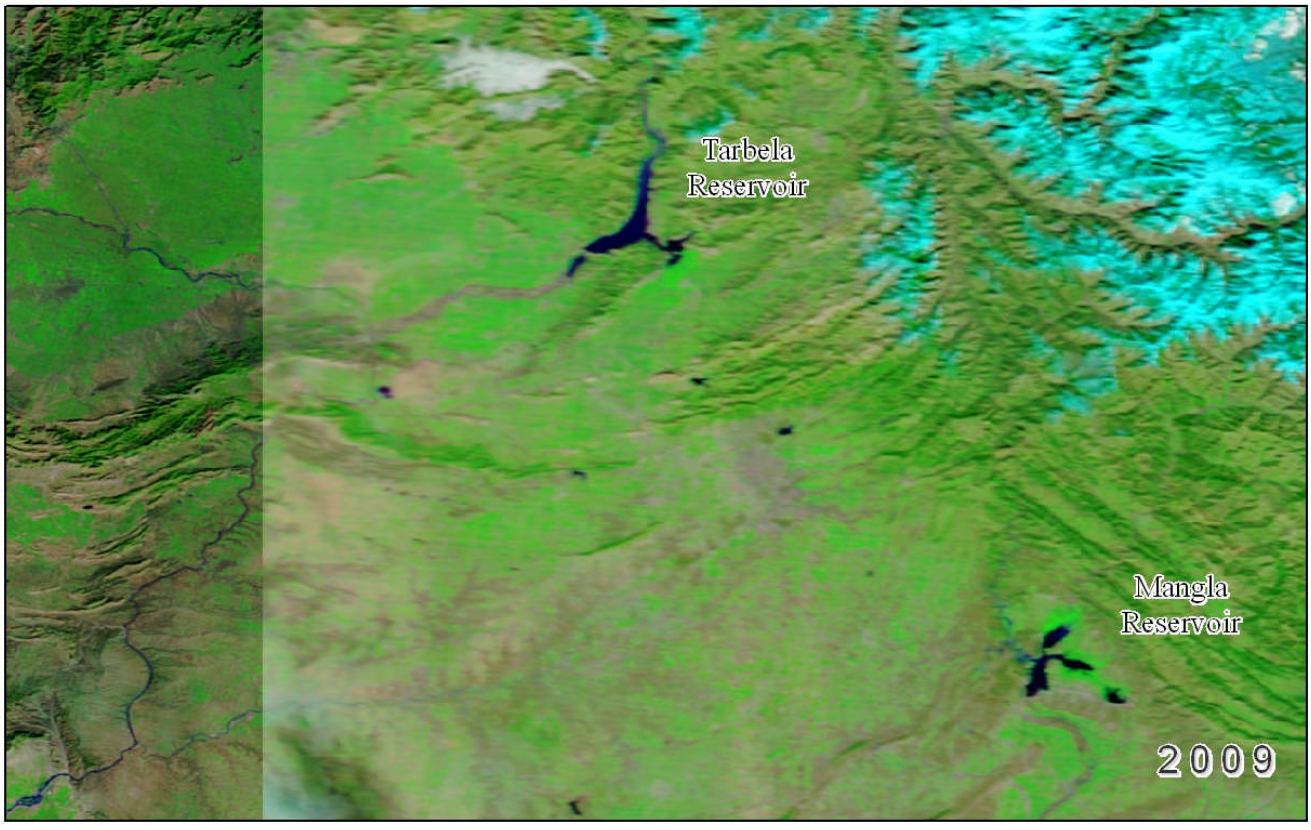


Figure 23. Tarbela Reservoir Dynamics, Mid-January, 2009 and 2010. *Data Source: Landsat (2010), AWiFS (2009)*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

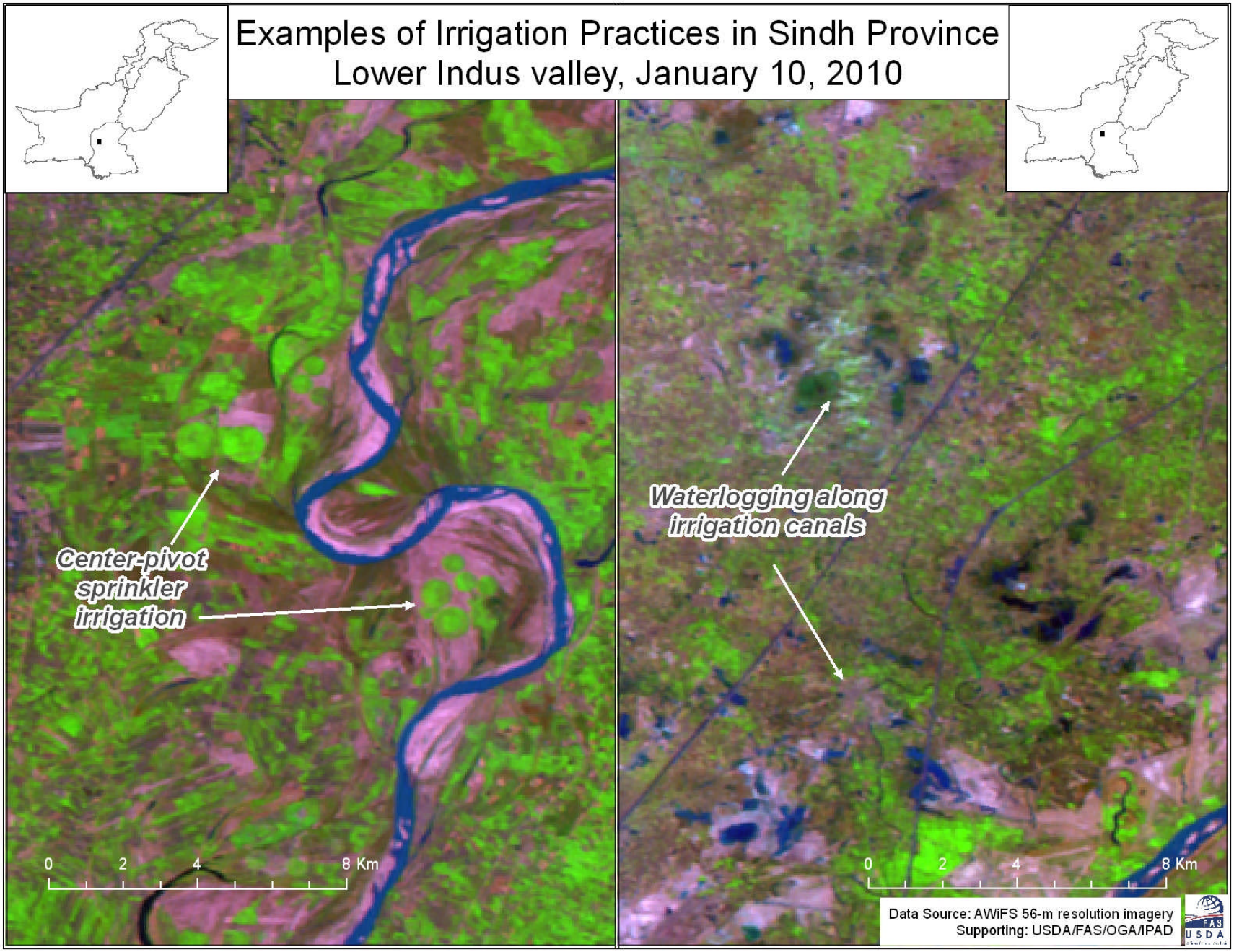


Figure 24. Examples of irrigation practices in Sindh. *Data Source: AWiFS 56-m resolution imagery, January 10, 2010*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

MODIS NDVI 6-yr anomaly local variations in Punjab and Sindh, December 18, 2009 – January 3, 2010

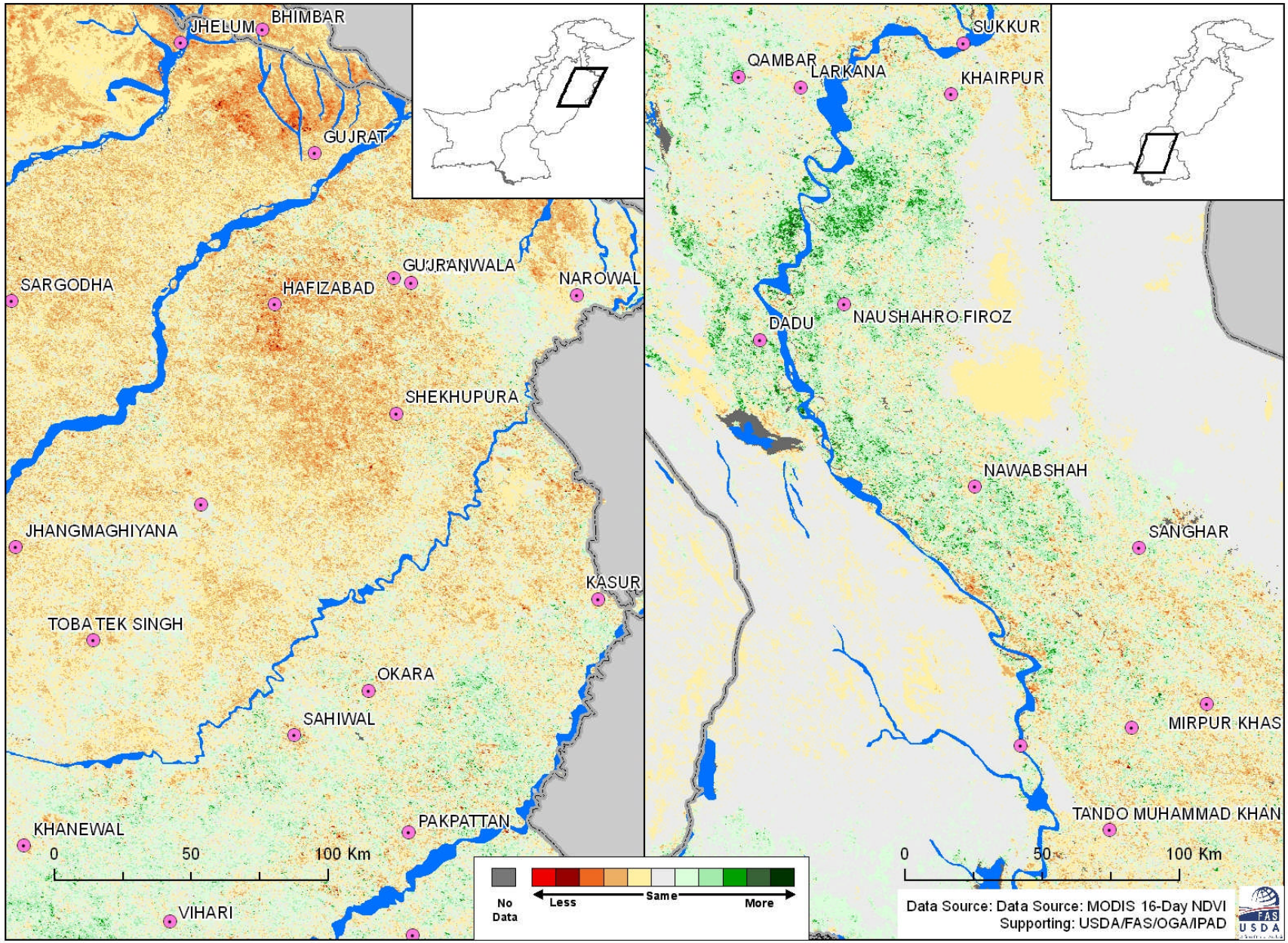


Figure 25. MODIS NDVI 6-yr anomaly local variations. *Data Source: MODIS NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

MODIS NDVI 1-yr anomaly local variations in Punjab and Sindh, December 18, 2009 – January 3, 2010

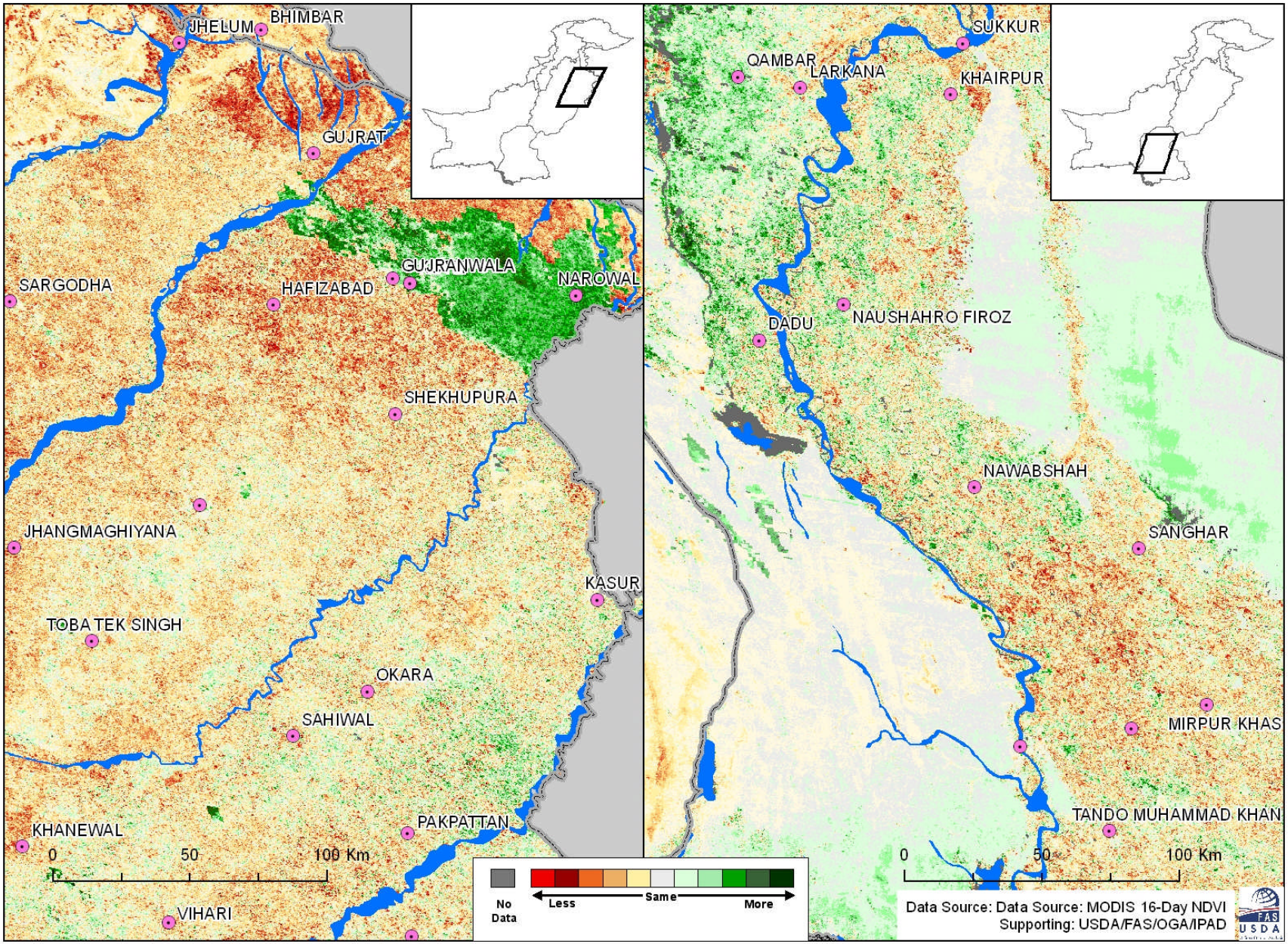


Figure 26. MODIS NDVI 1-yr anomaly local variations. *Data Source: MODIS NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

Change in MODIS NDVI for rainfed wheat area: MY 2010/11 vs. last year and 6-year average
December 18, 2009 – January 3, 2010

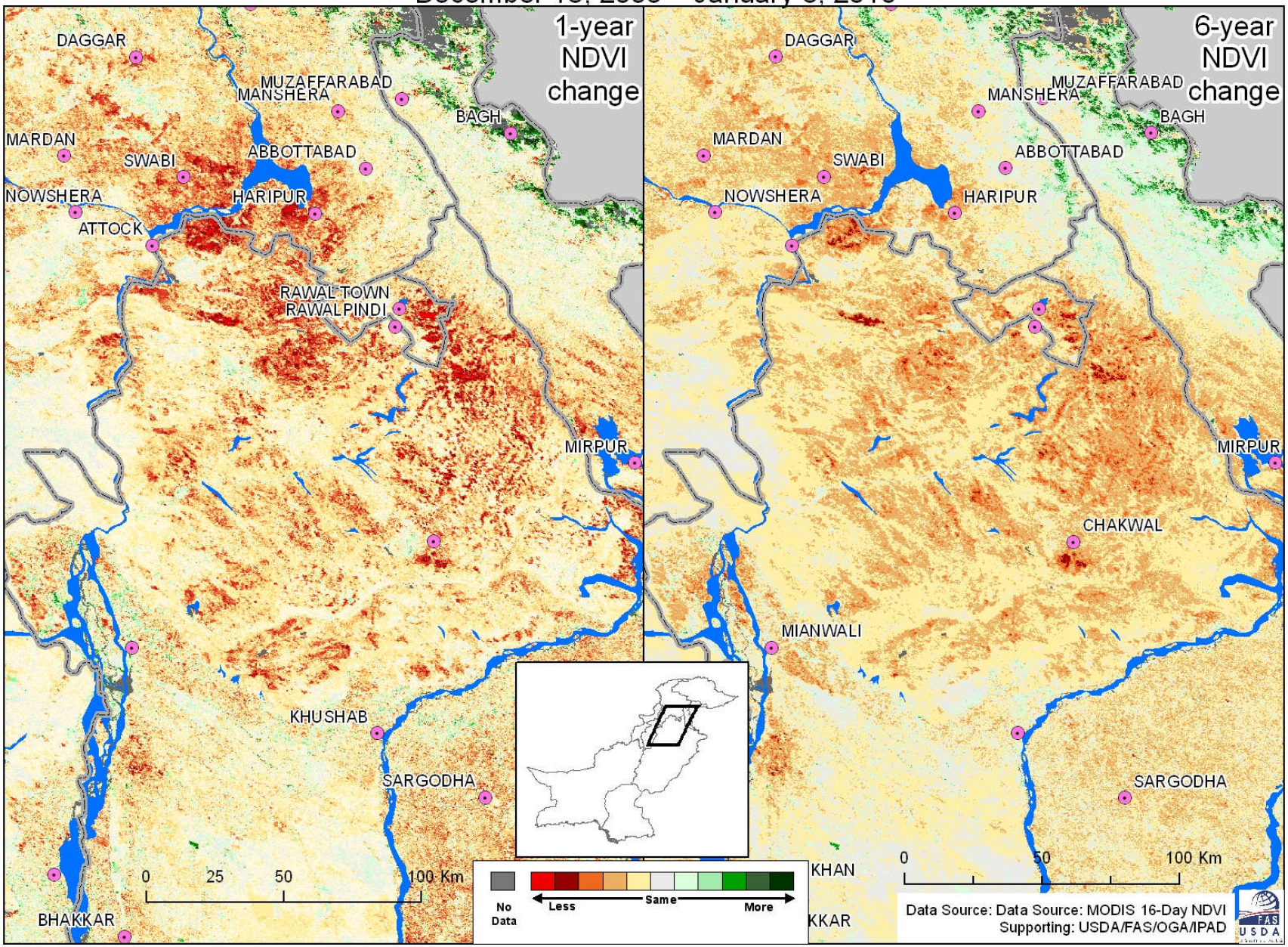


Figure 27. Change in MODIS NDVI for rainfed wheat area: MY 2010/11 vs. last year and 6-year average , Dec. 18, 2009 – Jan. 3, 2010. *Data Source: MODIS NDVI*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

7-Day Precipitation Outlook over Agricultural Lands: January 27 - February 3, 2010

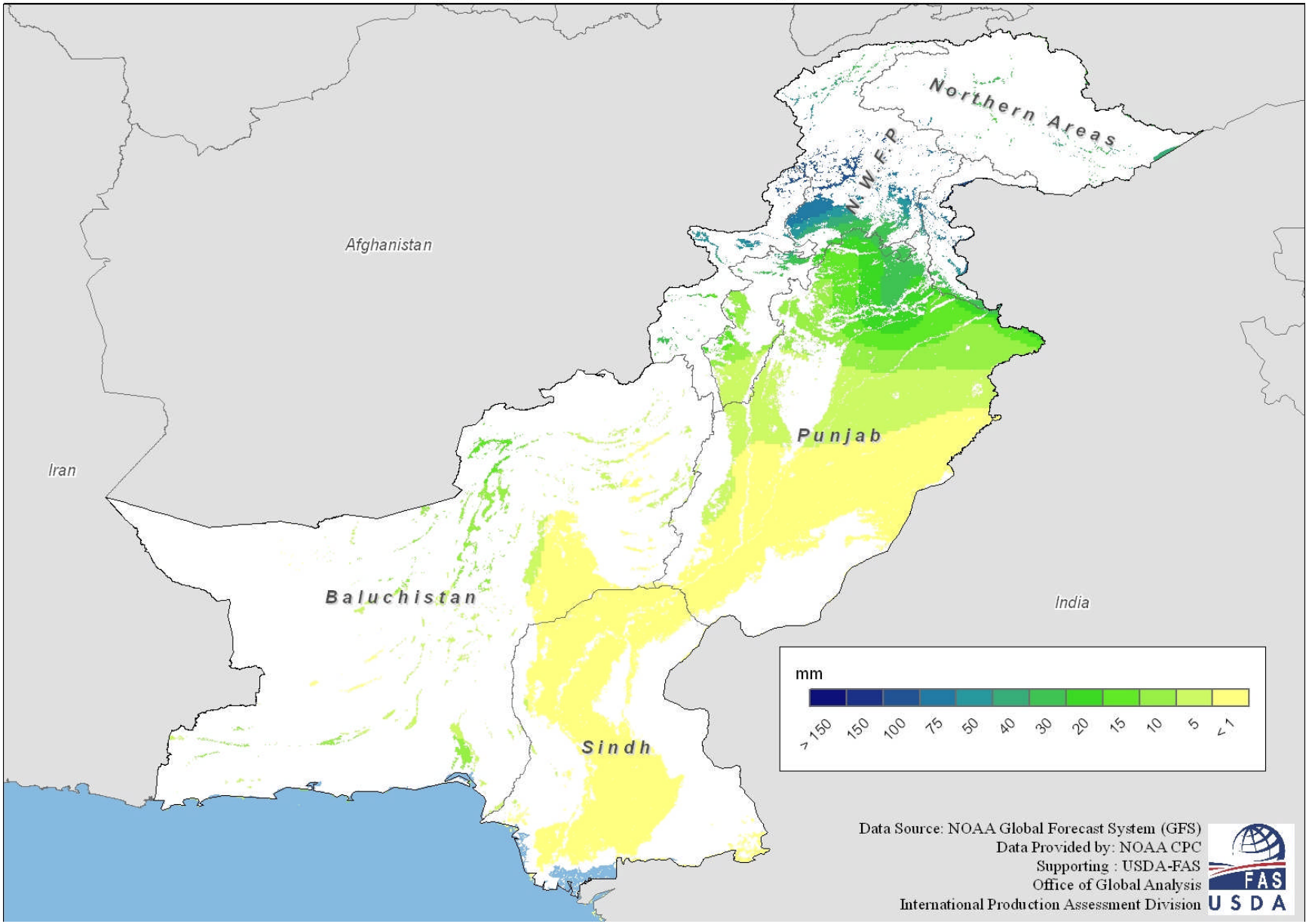


Figure 28. NOAA Climate Prediction Centre 7-day precipitation forecast for Pakistan. *Data Source: NOAA CPC*

APPENDIX

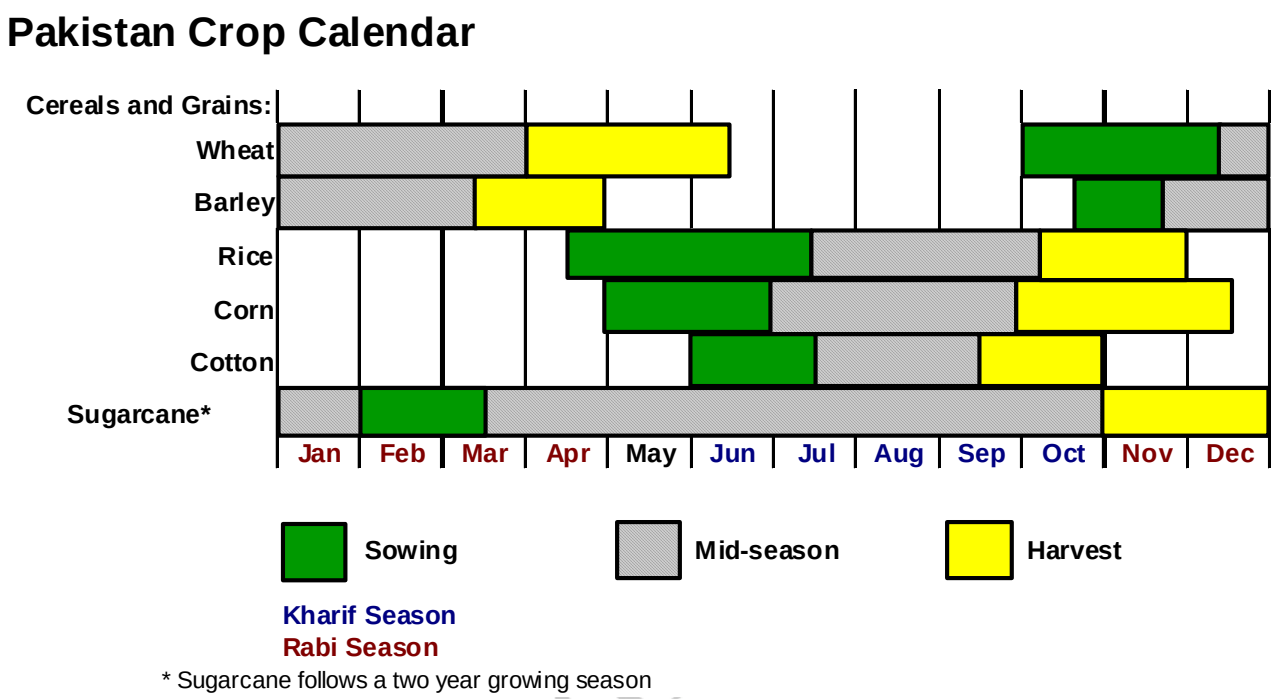


Figure A1. Pakistan crop calendar highlighting major crops grown during Rabi (Nov. – Apr.) and Kharif (June – Oct.) growing seasons. Calendar represents major production regions, timing of planting and harvest may vary regionally.

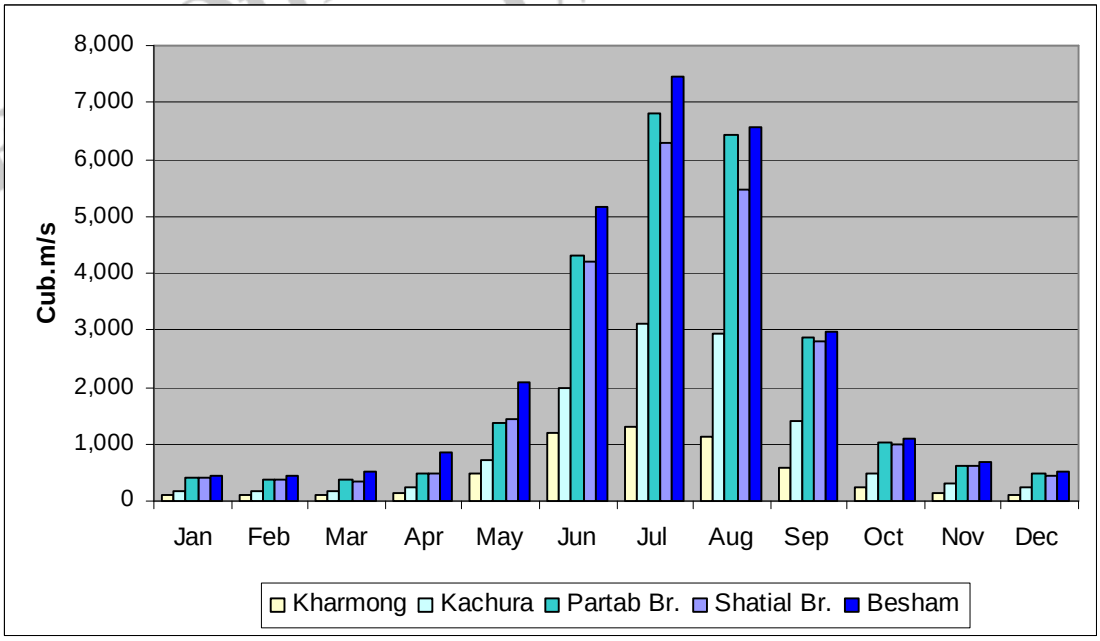


Figure A2. Average monthly streamflow in the Upper Indus River. *Data Source: World Bank.*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

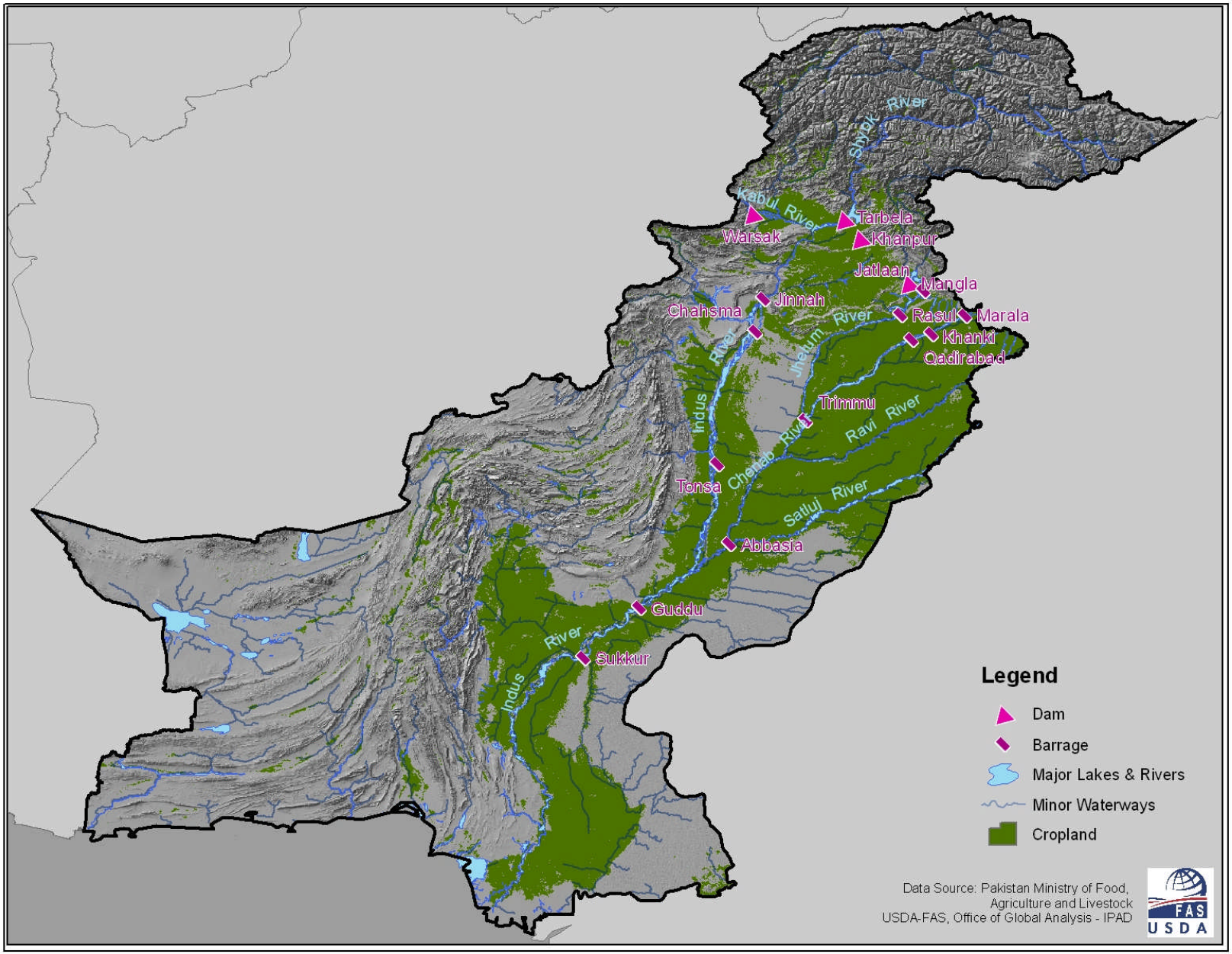
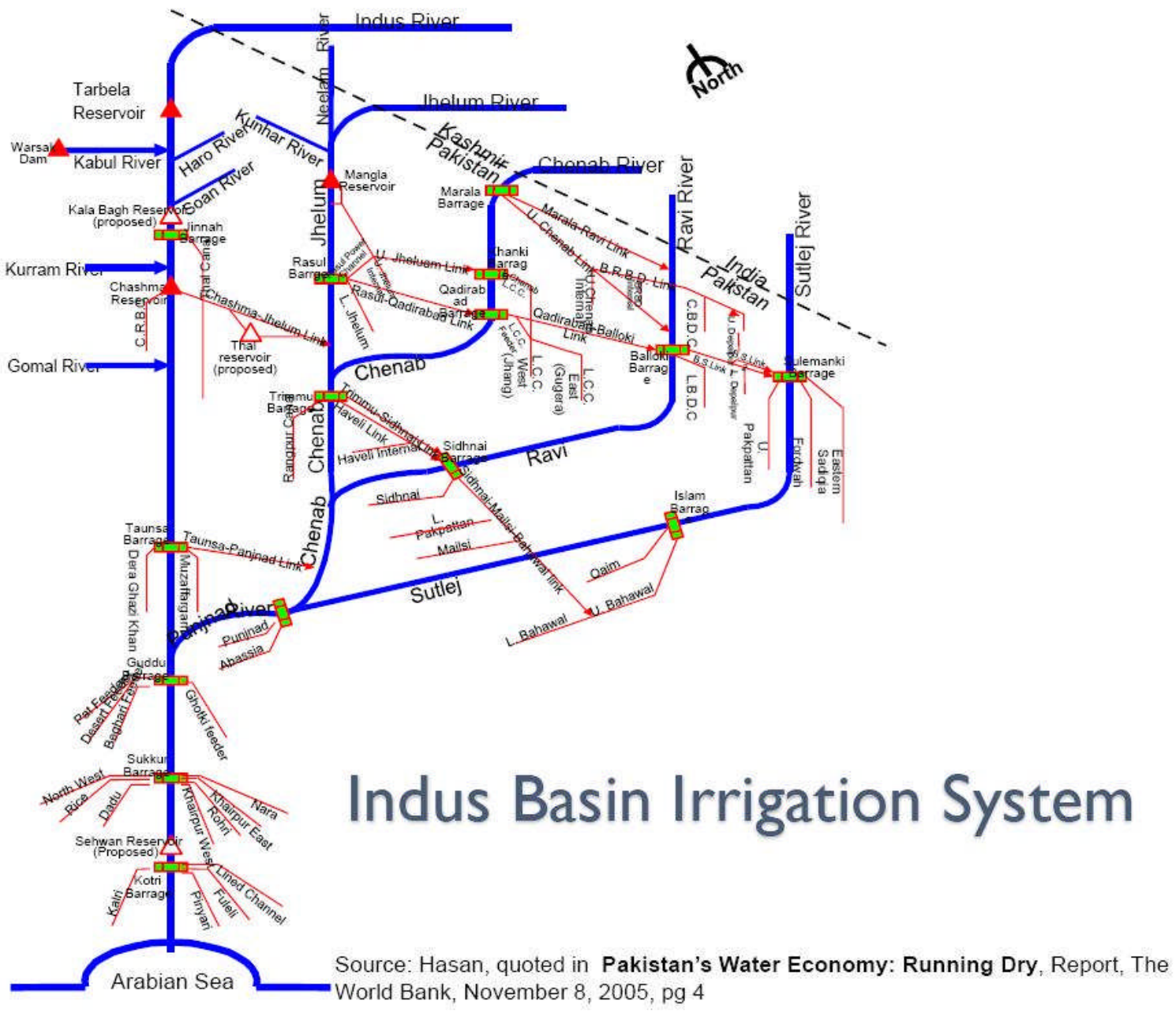


Figure A3. Major Pakistan rivers, dams and barrages. *Data Source: Google Earth*.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program



Indus Basin Irrigation System

Source: Hasan, quoted in **Pakistan's Water Economy: Running Dry**, Report, The World Bank, November 8, 2005, pg 4

Figure A4. Indus Basin Irrigation System (IBIS).

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

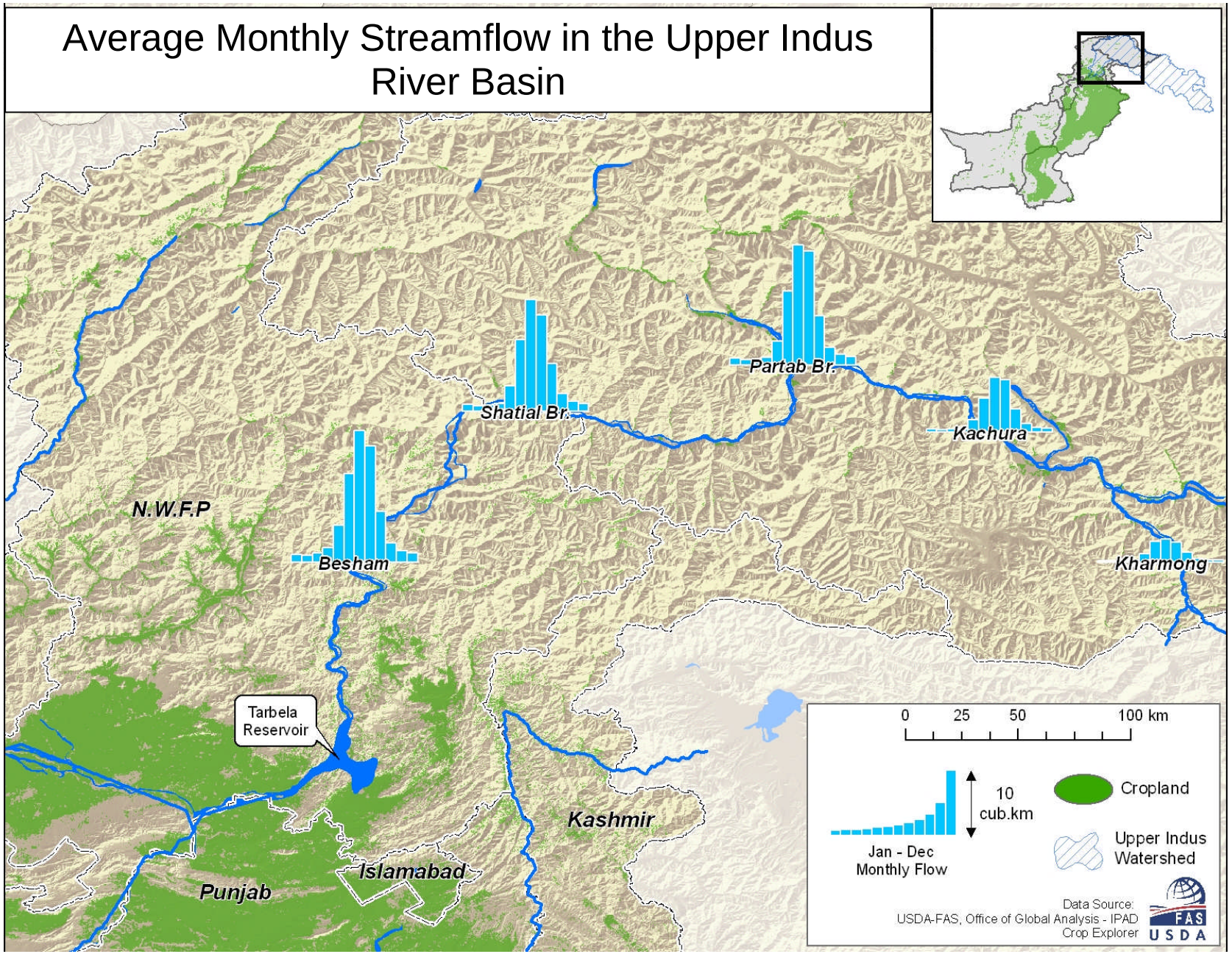


Figure A5. Average monthly streamflow of the Upper Indus River in Pakistan .

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

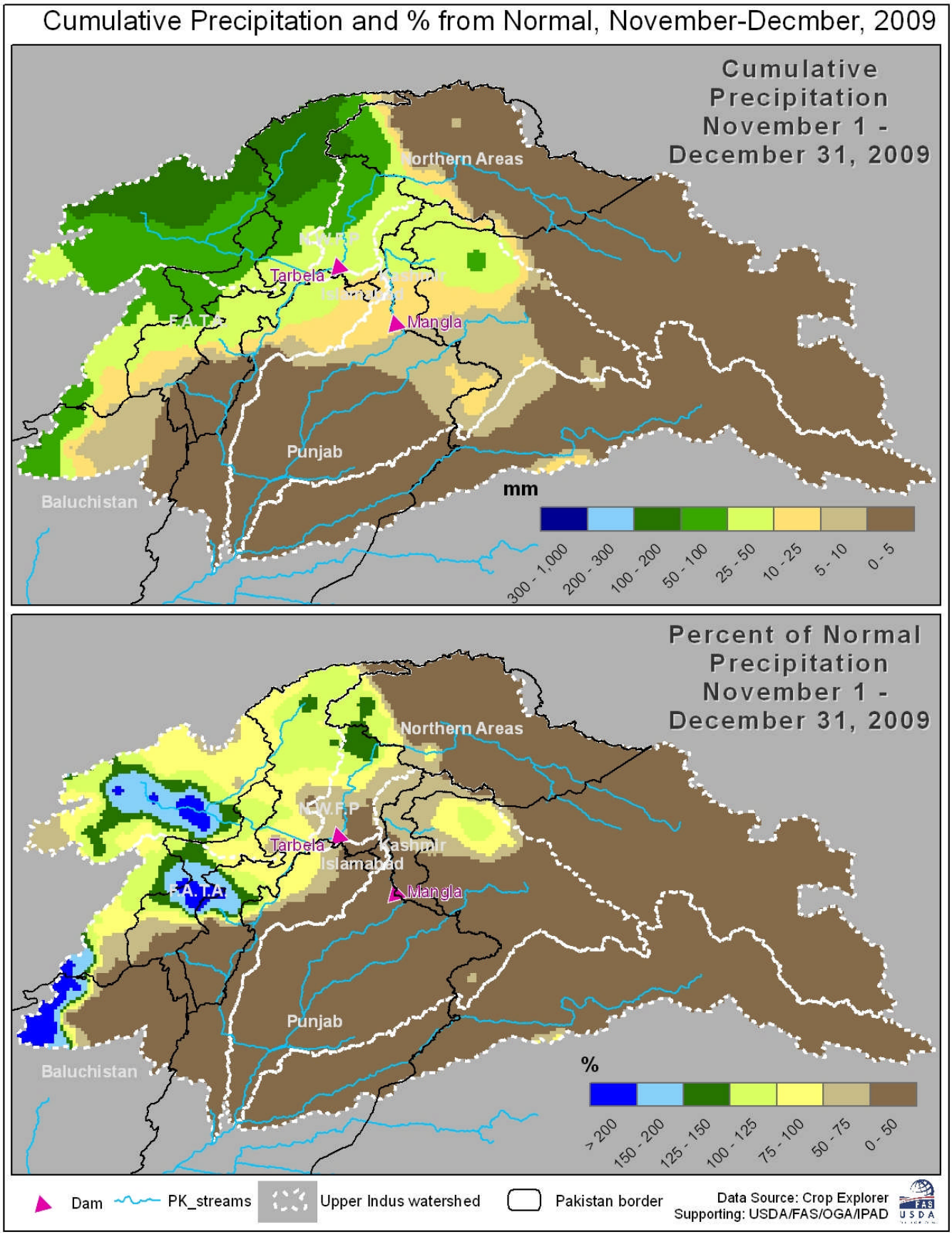


Figure A6. Upper Indus Watershed Precipitation, November - December, 2009. *Data Source: Crop Explorer*

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

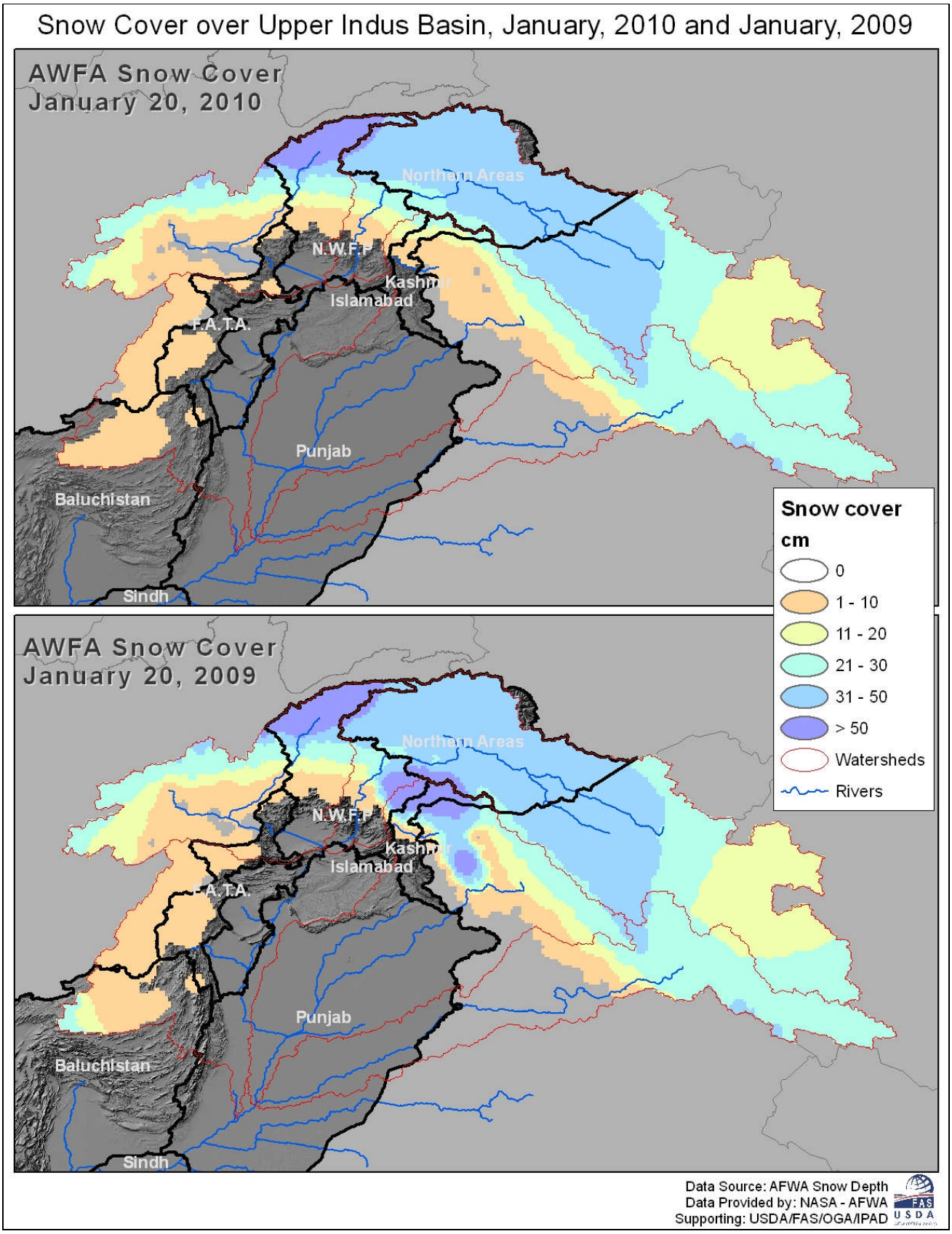


Figure A7. Upper Indus watershed snow cover and snow depth in January 2010 and 2009. *Data Source: AWFA.*.
Note: the disparity in area and location between the MODIS and AWFA snow products is a function of sensor resolution from which the data is derived.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

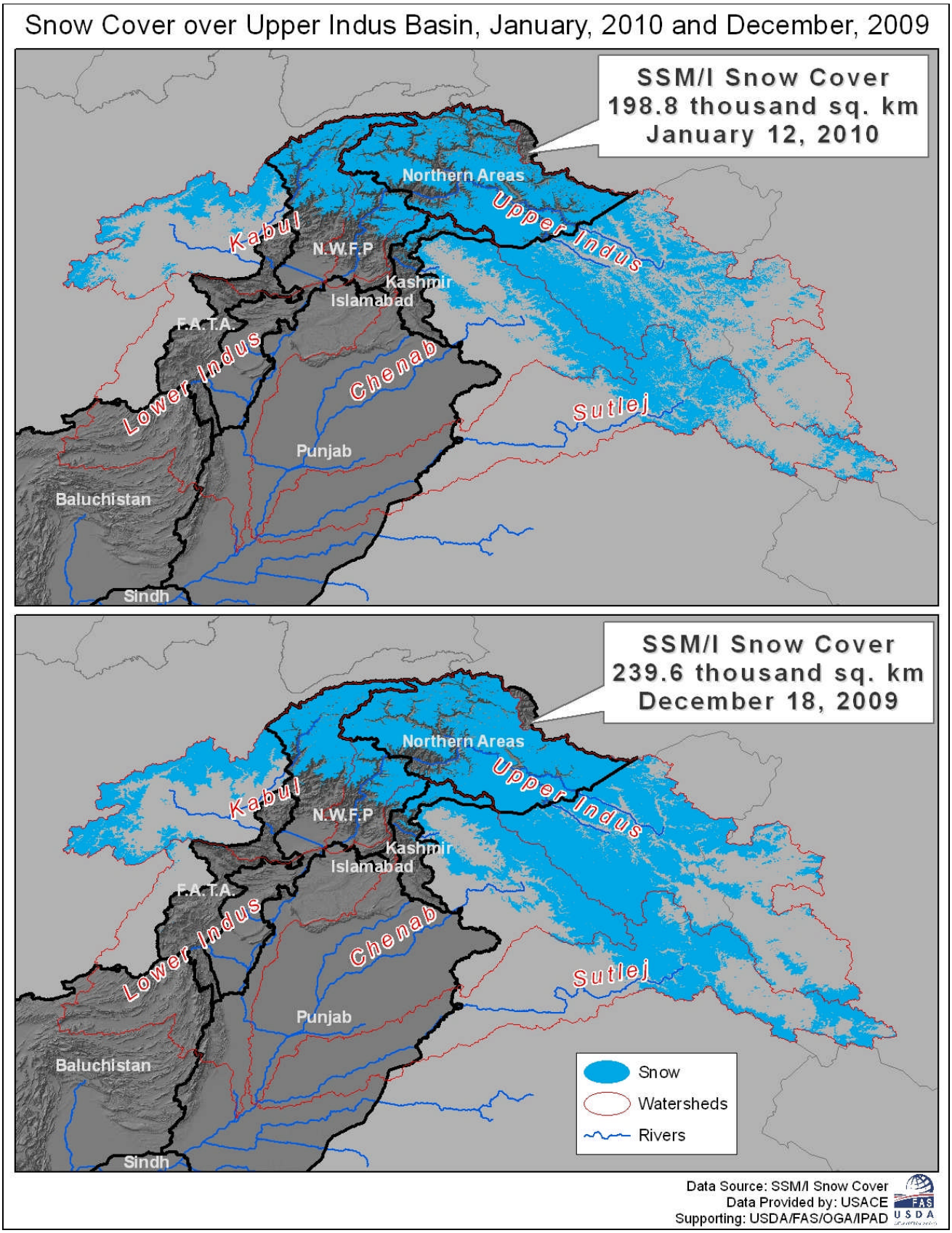


Figure A8. Upper Indus watershed snow cover in January, 2010, and December, 2009. *Data Source:USACE*
Note: Changes in snowpack properties, such as a rapid increase in average snow crystal size, can cause overestimation of snow water equivalent (SWE) volumes based on passive microwave data.

FAS – Office of Global Analysis (OGA)
United States Department of Agriculture (USDA)
International Operational Agriculture Monitoring Program

For more information contact:
Michael Shean | Michael.Shean@fas.usda.gov | (202) 720-7366 USDA-FAS, OGA or
Tatiana Nawrocki | Tatiana.Nawrocki@asrcms.com | (202)720-6652 ASRC Management Services